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AN AERO INDUSTRY MADE OVER NIGHT†

BY WALTER L. BROCK*

In the great conflict now raging over inflamed Europe, much dependence has been placed in the new aerial instruments of warfare which, for the very first time in history, are being seriously put to the tests which the militarist has expected them to meet. From time to time reports reach us that the aeroplanes and dirigibles are doing all that has been anticipated of them, but we in America know really nothing of what goes on behind the scenes of the present continental war.

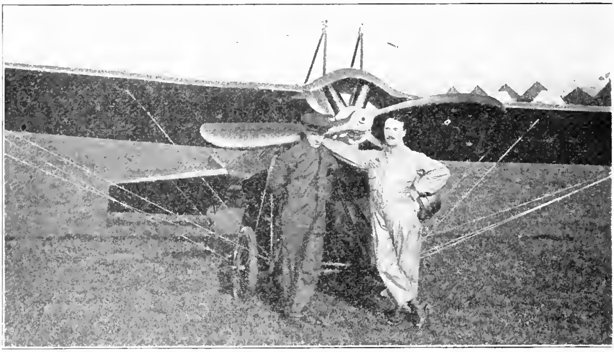
Although we have little real war news, there are indications that aircraft, for their invaluable part, are making their influence felt. The French government, as well as the British War Office, report that the work of the "fourth-arms" has been most excellent, doing about all that has ever been seriously laid out for them to accomplish. It was principally due to the efficient scouting of the French and English aeroplanes that the allies were able to prevent great losses of troops in the latter's defense and retreat by putting the General Staff in possession of information regarding the massing and advance of the German legions. But we learn very, very little of a definite nature—so we must be content, in the interim, to look upon this groping as an absolute necessity in the conduct of modern scientific war.

Nevertheless, I believe that aeronautics will come out of this, its supreme test, entitled to a fixed position among the chief instrumentalities of war credited with having more than justified the faith which the military have had in its potentiality.

†From an article in AERO AND HYDRO, rewritten by Mr. Brock.

*Class 1906. The author has been for several years Instructor in Aviation at Deperdussin Aviation School, Hendon, England. He was the triple winner of the three English aero classics of 1914, his machine being an 80 H. P. Morane Saulnier monoplane.

In England, the advent of war, however, elevated the relatively dormant business of constructing aeroplanes into a thriving manufacturing industry almost over night. The change was so Aladdin-like, that I could hardly believe the authorities had come to realize the importance of really pretentious aero corps as necessary adjuncts to both the army and navy. Previous to this



On The Aviation Field at Hendon, England. Mr. Brock at Left.

enforced manufacturing activity, England could not muster probably more than 115 machines in good shape for the army flying corps, and simliarly, 30 aero-hydroplanes for the naval air service—obviously not enough to effiiciently serve either major arm of the service.

But on the Sunday before I left, nearly all of the manufacturers notified their employees, who had been away on holiday leave, to return as soon as possible to their posts in their respective works. The Aircraft Company went even further than this. Their shops were started going full blast with considerable extra help that very Sunday afternoon. Every capable concern was immediately busy to capacity, either building machines to government design or producing their own individual types for the War Office.

The constructors who received these commissions were instructed to turn out air craft just as fast as they could, consistent

only with careful workmanship and the employment of high grade materials. This order was to stand until they were notified to lessen production.

So now, to replace those machines damaged or destroyed in service by the regular army and navy pilots and to provide mounts for the new reserve pilots and recruits—mostly civilians and newly developed service aviators—I should say that perhaps 25 or 30 machines are weekly added to the material at the disposal of both the Royal Flying Corps and the Naval Air Service. Or one might put it that the industry is being benefited to the extent of expenditures in excess of $160,000 per week for new machines and parts. Further, a very considerable sum is being expended for the maintenance of all army and navy aircraft and in carrying on the work at the Royal Aircraft Factory. And this has been going on since the first week in August, with no signs of immediate abatement.

Of the principal manufactories it is certain that the R. A. F. is capable of turning out four or five complete machines of standard type per week; that is, those machines designated as types BE 2, RE, RE 8, etc., which have passed through a great deal of experimentation and are favored as quite desirable for army work. Of the independent constructors, Vickers, Ltd., and the Bristol works are perhaps best equipped and can produce about four each per week. In fact, they are constructing to army designs (BEs) as well as turning out their own well-known products. The Short firm, whose works are very extensive, could do equally well, unless they were devoting a lot of their energies to repair work and spare parts, as it should be remembered that the navy has a big batch of Shorts. Sopwiths, the Aircraft Company, the English Bleriot works, the D. F. W., Pemberton-Billings and several others are on the list, all of them building good machines.

And in the motor branch of the industry we find similar activity and a gratifying impetus bestowed by the War Office. The Sunbeam motor car builders are producing their well-known aero engines, while Beardmore's are turning out Austro-Daimlers. English Gñome motors are also coming in for their share of popularity and large orders. Besides, the English constructors

were able to obtain a large number of French Gñome and Renault motors to aid them in producing the necessary air craft.

Most of the new hydroplanes are fitted with 160 H. P. Gñome or 200 H. P. Salmson engines. It is interesting to note the supremacy of the radial engine, with revolving cylinders for low powers, and stationary for the larger units. These will, beyond doubt, supersede all other types throughout the industry. Practically all the new land machines are being equipped with 80 H. P. Gñome engines. Just one more tribute to that light and reliable engine.

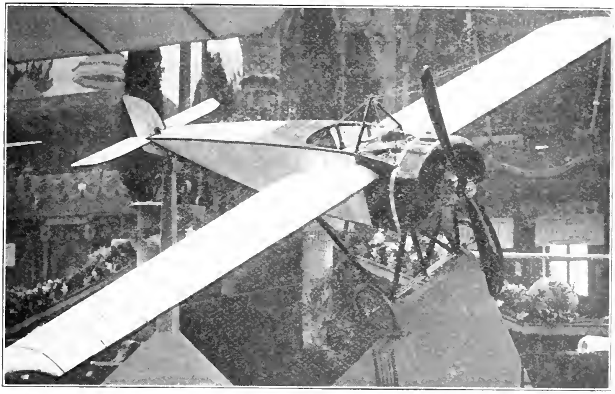
Dirigibles, though scarce in England, are being constructed by Vickers and the Armstrong, Whitworth firms, the former having three on order and the latter two. The R. A. F. is not at present doing anything in the dirigible line, as these types of aircraft are now under the complete control of the navy.

Yet, while England has to provide adequate material, she possesses a splendid large personnel in the men available to fly her machines, though, of course, many of them are not well experienced in military flying. Further than that, before I came away the well-known and popular civilian pilots, almost to a man, had volunteered their services and had been accepted. Some of these men have their own machines and so can add a fair increment to machines available. But it does seem to me that the great trouble will be the unfortunate lack of highly skilled pilots —men skilled in flying under severe conditions and practiced in taking accurate observations. With well developed designs of aeroplanes it is not so difficult to accelerate production of machines, but it takes a fair period to train men and adapt them to the arduous work required of the military and naval pilot. To minimize this difficulty and expedite matters the government has taken over the principal aerodromes and flying schools of the country and is training only those men who are intended for service with either the R. F. C. or the R. N. A. S. And the work of these embryo pilots is about trebled in order to give them some of the necessary experience before they join the areo commands.

As far as I am able to judge, about 50 British aeroplanes have been sent to France with the necessary men from the R. F. C. These pilots are working directly with the allies and

it is of their work that we have occasionally heard such good report.

But a big section of the government's fliers are being kept at home, though these are principally the navy airmen. There are certain people who believe that the Zeppelins are destined to raise havoc in England. This is quite practical, though im-



One of the Three Machines on the Morane-Saulnier Stand at the Paris Aero Show, December, 1913. This Machine is Similar in Every Respect, Except the Motor, to That Used by Mr. Brock.

probable, because of the many difficulties in the way. True, a Zeppelin hovered over Sheerness last year, which was one of the direct causes for England's post war aero activity in strengthening her air forces, but it is not believed that a Zeppelin bomb-dropping attack is a serious menace, among the aeronautical fraternity, at least. But to eliminate the possibility, the naval air stations at Calshot, Yarmouth, Aberdeen, Falmouth, Isle of Grain and at Eastchurch, the navy school, are kept at full strength and are daily receiving newly constructed machines and men. England, without doubt, has the finest naval air service of any of the powers engaged in the war and perhaps twice as many high-class aero-hydroplanes as any other power, which, one might suggest, is but in keeping with her supremacy on the seas.

With this healthly condition of affairs for the British constructor and the acquisition of hundreds of machines by the British government for use in the war, it is interesting to examine into the general types required. We find that the single-seater monoplane and biplane are well favored, though not bought in nearly the same quantities as two-seaters. As far as I am aware, no machines larger than those normally accommodating the pilot and one observer have been ordered. This prompts the interesting question as to what is the best type for the work in hand. For many reasons the single-seater monoplane appeal to me, for the reasons that it is a better wind machine, easier to transport, easier to assemble and take down, it is a comfortable machine to fly and less fatiguing in long flights. Its weight is less and there are fewer component parts in its make-up. As I believe that the greatest work of aeroplanes in connection with military operations is that of reconnaisance and the directing of artillery fire, the single-place scouting monoplane admirably answers the purpose. It is always hard for a pilot and observer to work in unison and since two monoplanes are generally sent out as scouts together so that the chances of one not returning are nil, it does not seem necessary to use the larger, heavier and more cumbersome types.

The biplane, however, has a big field and most of the new machines ordered are of this type, some of which are capable of 95 miles or more per hour in still air. The governments of Europe have spent large sums for several years now in developing the aeroplane for military work with the result that many men with high engineering ability have been engaged in this work and the results are only too apparent. Although America was the first to produce a practical flying machine, the best now made here could not be compared with most of the machines produced in Europe two years ago. Modern aeroplane design, though still young, has already reached the stage where the performance of a machine can be predicted with greater accuracy than is usually attained in ship design and many other branches of engineering. So when hearing of aeroplane performances in Europe we must bear in mind that they are carried out in machines superior to any seen in this country and by men with better training than any American pilot has been able to attain.

EFFICIENCY—EDUCATION

BY HERBERT W. MARTIN*

It is not the size of a manufacturing plant nor the number of men employed there that shows the ability of a superintendent or manager to direct operations. It is the efficiency of every working unit that tells the tale. The effectiveness with which a machine does its work, the competency of the operator in running the machine, and the thoroughness with which the department turns out the product, clearly illustrate the managing power of the man in charge.

In these days of keen competition and scarcity of skilled labor, the universal demand is efficiency and the problem of the technical man is to satisfy this want. He must be highly energetic and capable himself to accomplish this. He cannot have a desk in a nice office, call himself a master mechanic, assistant superintendent or what not and by looking wise hope to show results. He is a back number and will soon be forced out for a more up-to-date style of man.

Welfare work, safety first, and the much abused "Scientific Management" are all steps in the right direction, but education is the key to the final solution. Now at first glance, the term "education" may appear a very simple matter for we all have some sort of an idea what the word signifies. However, when we stop to realize that our manufacturers are now spending large sums annually to apply this idea, and that such men as Dr. Steinmetz, Chief Consulting Engineer for the G. E. Co., Dean Schneider of the University of Cincinnati, and many others, are not only interested in this new movement, but have actual charge of it in their respective spheres, it may alter our view point somewhat.

Take a glance at the ordinary shop. The men employed there are of three distinct types: (1) Those ignorant from choice, (2) Those ignorant because of unfortunate circumstances, and (3) Those who struggle for better things because of a suspicion that close application will help win success, or, at least, a better job.

It makes no difference whether we investigate the selling end, production end, or the business end of the organization, the above three classes will be found side by side. Such a condi-

*Class 1910. Chemist, International Harvester Co., Milwaukee.

tion certainly does not spell efficiency. Here then is the problem,—how to handle these men, to put brains and energy into every operation, thus increasing output to a maximum and cost of production to a minimum.

The solution of this is being sought by all our leading industrial and business houses. Varied experiments are being tried, but practically all agree that lack of training and education is the seat of the difficulty. Here the technical man can enter the field successfully or not as his abilities and experience warrant.

Generally speaking, the three types of workers may be classified as young or old. For obvious reasons the old employee will be eliminated from our discussion. By the young worker is meant the apprentice boy and others up to about 25 years of age. Also, although writing of the male worker, the general idea of these statements includes the female worker, as those employed in hat factories, retail stores, etc.

First, to show how mutually satisfactory to employer and employee this idea of training is: the magnificent and complicated machines of today do nearly everything but think. However, they require brains to run them. If three motions are made where one would suffice, two-thirds of the time is lost. If a worker spoils a third of his work through inability and a better man cannot be found to fill his place, the loss will have to go on. In other words, if the efficiency of an organization is 55% how can it be raised to 85 or 95%? No company can afford to do business on a 55% efficiency basis. The men have got to be trained, taught to prevent lost motion, wasted products, and unprofitable work.

From the employee's side this instruction is quite as essential. The high cost of living, rapid multiplication (not mathematics) mean that his very existence depends upon ability to earn a livelihood. He gets just what he can earn and rises just as high as his abilities warrant. To get larger wages his earning power must be increased. Hence he needs what his company can supply him with, and his company needs his trained services. The demand is mutual and the result satisfactory.

By the education of shop men we do not mean a night school or college course, but a thorough grounding in the principles governing those thing with which he comes into daily contact. That

is, the ground to be covered depends on (1) the class of employes to be taught; salesmen, office men, technical men or shop men; (2) what subjects are to be given; (3) where these subjects are to be given; (4) when given; and (5) how given.

To us, the apprentice boy presents the most interesting phase of this work, and it is the continuation school for this class of worker which will be discussed. The modern apprentice either wants to learn a certain trade, or is forced to learn it. Obviously then, the first step in the educational work is to eliminate this bad feature of forcing a boy to do what he does not like. For this reason the first year of our system is practically the same for all the boys. During this time the instructor with the aid of the foreman finds what the boy is suited for and he is then allowed to work in that department.

The system is this: A boy seeks employment and if he has the proper credentials is admitted to the factory. For three months—probation period—he is closely watched and his manners, habits, and ability, carefully noted. At the end of three months, if satisfactory, he is allowed to begin in the continuation school.

Where he starts depends on his previous education. The average boy has had about a 7th grade training and is 17 or 18 years of age. We prefer a boy who has graduated from the grammar school, however. The first year's work consists of shop arithmetic, and the reading of a geographical reader and trade catalogues. The first year over, he is placed in the department for which he seems best adapted and then becomes a regular apprentice.

The second years' work in school includes higher shop arithmetic, composition, health and hygiene, and freehand sketching. All subjects relate to his trade as closely as possible. In the third year he studies geometry, shop drawing, civics and mechanical drawing.

The fourth and last year takes up mechanical drawing, trigonometry, the shop (department by department), lectures and inspection visits about the factory and city. At the end of the fourth year the boy receives a graduation certificate, although he still has one more year to serve at his trade.

In the shop his practice work is made as progressive as possible; that is, he is not left at one task so long that he loses inter-

est, but as fast as he becomes proficient in one operation or with one type of machine or tool, he is given a new problem and advanced to more difficult and complicated work. This system prevents a narrow-minded foreman from hindering a boy's progress through jealousy or spite. It is a curious fact, but this education of the shop boy soon shows up the foreman. A narrow man cannot bear the idea of the interest shown in the boy by higher officials and throws every obstacle that is possible in his path. The broad gauged man, on the other hand, not only helps the young fellow in every way possible, but keeps in touch with the work of the class room as well. In a few years a weeding out process of the foremen begins without any help from the office, merely because it is a natural sequence of events, narrow mindedness and old fashioned ideas driven out by education and training. Here we find increased efficiency naturally obtained.

Throughout the course the work of the class room and shop are closely related and depend upon each other. This, of course, holds the student's interest as nothing else could. The class room is situated in the shop and resembles any ordinary school room with its blackboards, maps, pictures, etc. After a boy has worked hard all day he is really unfit for night study or night school. Because of this fact and because we believe that a good physical condition is necessary from an efficiency standpoint, he is allowed two hours twice a week during working time, to attend school, for which he receives his regular pay. This has proven very satisfactory.

The whole success of the system depends on how the subjects are taught. The boys are not students, most of them do not want to learn as ordinarily understood, but they are interested in their work, and if the relation between it and the class room is clearly defined the task is easy and their progress is astonishing. To illustrate: It would be mere folly to state to the boys that the circumference of a circle is $2 \pi R$, for they don't care if it is. However, if every fellow is given an iron disk of a different size and each one told to make a careful measurement of the circumference and diameter and then divide one into the other, the result is different. They all get practically the same answer and wonder why it is. Then if π is sprung on them, they take it as a duck to water, and further still they keep it and use it. This example illustrates the method of instruction.

The instructor must first of all be a technical man of wide experience and training. He must be enthusiastic and sympathetic in all his dealings with the boys, for it is quite a task to get the first hold on their confidence, but after that it is easy. It is interesting to study the fellows during the first few months of the class room. At first some are suspicious, some cool and indifferent and a few really serious, but after a little an awakening takes place, faces are brighter and clearer, new interest is shown, and the fellows are awake, probably for the first time in their lives, to the possibility of a successful future, instead of a mere existence such as their fathers and father's fathers lived before them. A careful talk or two and cigarettes and chewing tobacco are discarded, also other bad habits, and the effect of a few months is really startling, eyes are clearer, color better, and work better done. The efficiency is raised to a surprisingly high figure due to the efforts of the boys alone.

Four years of this training results in excellent material for foremen and even higher positions. These fellows soon surpass their fellow workers in wages and responsibility and the height to which they may rise is unlimited, being that of general manager in several instances.

As has been previously stated, the continuation school work is not only applicable to the shop boy, but to all young men wishing to enter any branch of an organization. Further, it is absolutely essential that each concern train its own salesmen, own engineers, office men, and shop men, to meet its particular needs and requirements. The results are comparable with those obtained by instructing the apprentice boy and it all means efficiency of the highest type.

With a shop full of skilled workers; an office force trained to do its work quickly and economically; its salesmen able to get customers and to keep them; and its technical men thoroughly posted on the engineering side of the business, its methods and systems, an organization will be able to meet the keenest competition successfully because its efficiency is maximum. Particularly every technical man should keep this clearly in mind when seeking a position or fitting himself for a certain branch of service. Our organizations have no place these days for the unskilled or inefficient worker.

METALLURGICAL PLANTS IN THE VICINITY OF CHICAGO

BY H. B. PULSIFER*

In the early part of this year one of the trade journals made an interesting presentation of the metallurgical plants about New York City, claiming that city to be the greatest metallurgical center in America. We are well aware that the electrolytic copper refining industry of our country, which is by far the largest in the world, is largely concentrated about New York; further than this, however, New York can hardly withstand critical comparison with several cities, such as Birmingham, Buffalo, Pittsburgh or Youngstown. Any one of a dozen steel plants scattered about the country employs more men than are at work in all the metallurgical plants about New York. Any one of the four plants near Salt Lake City treats a greater daily tonnage than all the works about New York. New York is typically a center for the refining of the more valuable metals—platinum, gold, silver and copper; including one idle plant and one proposed plant, twenty plats comprise the entire list of metallurgical works about the great metropolis.

We have selected *twenty-five* plants to indicate the importance of the metallurgical industry centering about CHICAGO. The South Works of the Illinois Steel Co., at South Chicago, employs more men than are engaged in the entire lead smelting and refining industry of the United States; the same plant employs more men than are at work in *all* the metallurgical plants about New York City. Chicago is the largest and most important lead refining center in the world. Only the Pittsburgh district exceeds the Chicago section in the production of iron and steel. For various features the plants about Chicago attract wide attention as excelling anything similar in the world.

1. The South Works of the Illinois Steel Co.

This plant covers 400 acres and at capacity employs 10,000 men. It has 11 large blast furnaces capable of producing 1,500,000 tons of pig iron a year. It has 24 basic open hearth steel furnaces, 3 Bessemer converters and 1, 15-ton Heroult elec-

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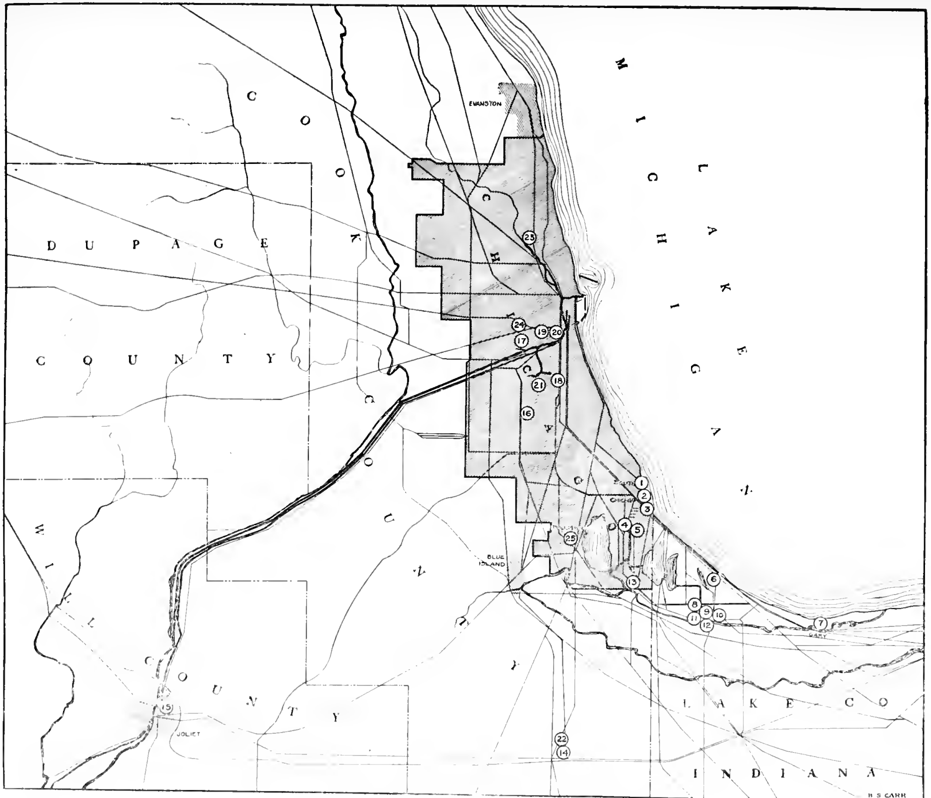

Metallurgical Plants in the Vicinity of Chicago.

1. Illinois Steel Co. (South Works)
2. Iroquois Iron Co.
3. American Smelting & Refining Co. (National Plant)
4. Wisconsin Steel Co.
5. Federal Furnace Co.
6. Inland Steel Co.
7. Indiana Steel Co.
8. Republic Iron & Steel Co. (Inland Works)
9. International Lead Refining Co.
10. Grasselli Chemical Co.
11. Goldschmidt Detinning Works.
12. United States Metals Refining Co.
13. General Chemical Co.
14. Columbia Tool Steel Co.
15. Illinois Steel Co. (Joliet Plant)
16. Goldschmidt Smelting & Refining Co.
17. National Malleable Castings Co.
18. Great Western Smelting & Refining Co.
19. National Lead Co.
20. Crane Co.
21. Chicago Bearing Metal Co.
22. Edgar-Allen Manganese Steel Co.
23. Illinois Malleable Iron Co.
24. Otis Elevator Co.
25. American Steel Foundries Co.

tric furnace. The plant has rail, slab, plate, blooming and structural mills. A Gayley dry blast equipment is available although seldom used.

In the matter of economics and establishing records this plant has no superior; it has a remarkable record for training men to operate other plants. It affects a certain pride in being known as the "University of South Chicago"; the heads of departments average around 30 years of age.

2. Iroquois Iron Works.

This merchant iron plant of two stacks at South Chicago is a model plant. The two stacks are of large capacity, of recent and most modern construction. The power plant is superfine while the grounds are beyond criticism in tidiness.

3. National Plant, American Smelting & Refining Co.

A Parkes' process lead refinery of 8,500 tons per month maximum capacity. This plant has figured prominently in the development of lead refining technique and now probably exceeds any other plant in attention to the details of the hygienic side of the industry. Operating costs and recoveries have long been cardinal virtues of the staff while at the present time almost daily advance is made in sanitary arrangements for the workmen.

4. Wisconsin Steel Co.

This plant has 3 blast furnaces and 2 Bessemer converters as the main equipment for changing ore to steel. The plant is at South Chicago; it has established a splendid safety record; progress is continually in evidence with splendid furnace performance.

5. Federal Furnace Co.

This small plant of two stacks at South Chicago has no unusual features.

6. Inland Steel Co.

Two large modern stacks and 12, 60-ton basic open hearth steel furnaces are the central features. 66 by-product coke ovens and a new 90-in. sheared plate mill are additional departments of note. The various other mills have interesting equipment; visitors find a small compact plant of this sort affords more attention and nearer approach to operations than is to be expected in the great plants such as the South Works or Gary.

7. Indiana Steel Co.

The plant of this company, at Gary, Indiana, is one of the world's greatest steel plants. There are 8 of the largest blast furnaces, 42 basic open hearth steel furnaces, 560 by-product coke ovens and 23 huge gas engines. The rail and billet mills are the largest in the country, while the gas engines develop over a million horsepower daily. In less than seven years the city of Gary has attained a population of some 30,000, this accruing from the establishment of this particular plant on a 9,000 acre tract of the sandy waste along Lake Michigan. A trip about the plant in an observation car affords a good conception of the size of the plant.

South Works of Illinois Steel Company from Iroquois Plant.

8. Republic Iron & Steel Co.

The Inland Works plant of this company at East Chicago has 14 puddling and 8 busheling furnaces available. As the only works of the sort in the section it adds well to the variety of metallurgical plants.

9. International Lead Refining Co.

This Parkes' process lead refinery at East Chicago is the most recent refinery in the country. It has a capacity of 5,000 tons

per month; 2 Pattisonizing kettles are available as adjunct equipment when necessary.

The exceptionally well designed arrangement with the latest equipment, including a very fine bag house, mechanical devices and efficient management makes the plant of very considerable interest.

10. Grasselli Chemical Co.

At this plant located at East Chicago the particular metallurgical features are the furnaces for roasting zinc ores. The making of sulphuric acid is an important part of the work and various furnaces are in use; for further treatment of the roasted zince ore the material is shipped to eastern plant.

11. Goldschmidt Detinning Co.

The large modern plant of this company at East Chicago removes tin from scrap plate. This plant is not open for inspection.

12. United States Metal Refining Co.

This large modern electrolytic lead refinery has a monthly capacity of some 4,000 tons. Recent enlargements enable it to serve the full western company operations. Raw lead bullion from the two western plants of the company is treated; and products are electrolytic refined lead, electrolytic bismuth, hard lead for alloying, dorè silver and copper matte for further refining at the company plant at Chrome, New Jersey.

13. General Chemical Co.

At Hegewisch this company maintains a very large chemical plant; the roasting of zinc ores is a step in the production of sulphuric acid and one important detail of the works. The plant is not open for inspection.

14. Columbia Tool Steel Co.

At Chicago Heights one finds this delightful little crucible steel plant. Its proprietor is equally hospitable, taking pride in the business and the excellence of his own plant as well. A remarkable record has been established in the operation of the gas-fired crucible furnaces. It is the only plant of the sort in this part of the country.

15. Joliet Plant, Illinois Steel Co.

Four blast furnaces supply the 3 Bessemer converters which make the steel for 2 billet, 2 rod and 2 wire mills. A by-product

coke plant of 280 ovens supplies the blast furnaces. The regular attendance of students from this plant at Armour Institute, daily coming and going, proves the plant in the Chicago district.

16. Goldsmith Bros. Smelting & Refining Co.

This plant is really a refinery for gold, silver and platinum, using the wet methods. Lead serves as the collector in working up scrap material and producing the dorè. Parkes' process is used to collect the precious metals from the lead. The plant has blast furnace, reverberatories, desilvering kettles, bag house and is now installing a continuous roast-sintering machine. One would hardly expect to find a plant of this sort at 58th and Throop, Chicago.

17. National Malleable Castings Co.

In the numerous air furnaces and annealing ovens the metallurgist finds himself at home in this great plant for the production of malleable castings.

18. Great Western Smelting & Refining Co.

At 42nd and Wallace, Chicago, one finds again reverberatories and a blast furnace which likely excell in neatness and design even the far-famed copper furnaces of Swansea.

19. National Lead Co.

This plant for the production of white lead and the oxides, situated in the very heart of Chicago, also has in its metal department equipment which partakes of purely metallurgical character.

20. Crane Co.

In the iron and steel foundries of this company converters and cupolas partake of such excellences to be of particular note. Besides the usual interest in the routine development the staff has been conspicuous in metallurgical research. With the completion of the new plant at Clearing the company will doubtless set new standards in this phase of metallurgical manufacturing.

21. Chicago Bearing Metal Co.

In some far distant mountain region of the western states one may find a round copper furnace making metal; a furnace after the same plans may also be found running the red metal at this plant in the very heart of the stock yards. This with other furnaces makes quite an interesting exhibit for such a grain and cattle center as the Windy City is commonly more noted for.

22. Edgar-Allen Manganese Steel Co.

This company has a large plant at Chicago Heights.

23. Illinois Malleable Iron Co.

The several plants of the company doubtless afford plenty of metallurgical features.

24. Otis Elevator Co.

This company is commonly credited as having the largest steel converter equipment in the city.

25. American Steel Foundries Co.

The various enormous plants of this company cannot fail to afford abundance of metallurgical equipment.

Open Hearth Plant of Inland Steel Company.

The plants about Chicago cover a wonderful range in both variety and size; as a combination summary one familiar with the district has ground for the claim that Chicago is *the* metallurgical city of the world. The author spent several days during the last summer at the plants about New York; some of them received him and camera with goodwill, most of them cannot even be entered by honorable means. The great metropolis offers a meager display compared to what Chicago affords. Chicago has 50 brass and 75 iron foundries.

Inspection of the map affords an insight as to the reason for the presence of all these plants at this locality. First, the mass-

ing of people and railroad facilities calls for the numerous plants in the city and at inland points. Again, the short water haul to the Lake Superior iron mines with the splendid water facilities offered on trunk railroads accounts for such of the remarkable plants as are at South Chicago, Indiana Harbor and Gary.

The great labor market, the cheap coal, the magnificent railroad facilities and the water way to the iron mines makes the combination hard to exceed. The railroads are not only so wonderfully numerous and interesting but being trunk lines from East to West afford unique conditions.

A pertinent question might arise: Why is there no great metallurgical school at such a wonderful metallurgical center? Why is metallurgy taught only at Armour Institute and as a minor branch in the Chemical Engineering Department? Is there no call for technical metallurgical education?

We believe the time will come when there will be a great and well met demand for the training of young men educated at local schools. At the present time Chicago is such a young city and the industries which have located here are so young and vigorous that making money does not require particular refinement. The plants are undeniable operated and managed largely by men of more business than technical ability. Graduate apprentices are practically absent in every plant. Many plants have absolutely no apprentices in minor positions. On necessity major places are filled from outside plants or by too rapid promotion. Local technical schools will be of the utmost service in preparing young men to stabilize and advance the industries. Young men graduating from Armour Institute find remunerative employment without the drudgery of years spent in the works. Technical graduates started on the strenuous highway toward operating directorships too often yield to the lure of the analytical laboratories. The works are ready to absorb the young men and the field is open for the establishment of far greater technical metallurgical education than is at present available in the district.

Does Armour Institute profit by the presence of all these metallurgical plants about it? A considerable number of students from and for the plants are always in attendance for in-

struction along this very line. The small classes in metallurgy make inspection trips to many of the plants each year. As a general rule the students are not sufficiently advanced to make full use of such good offices as most of the plants are willing to afford.

In elementary metallurgical instruction the plants serve a good object lesson and afford definite ideas about the industries but the main instruction must be upon fundamentals in the class room and laboratory. A real value attaches to the plants for the enlightenment of the instructor; at many plants he is welcome; even given the freedom of the plant with the courtesy of using the camera. This all redounds to the advantage of the student. The co-operation of the Institute and plant through the advanced student or developing engineer is yet more wished for than accomplished because of the small metallurgical interest of the Institute as a whole.

SOME COMMENTS ON THE PATENT SYSTEM

BY THOS. A. BANNING, JR.*

The patent system of this country has been very severely criticized from time to time on various grounds, and particularly for the reason that the granting of a patent to an inventor does not in and of itself convey to such inventor protection for the exclusive use of his invention in the sense that the patent system does not provide for the institution and prosecution of suits against alleged infringers by and on behalf of the government or people of the United States. This is one of numerous criticisms which have been directed and are being directed against the patent system at the present time. These criticisms are by no means new, but they have become more frequent, and in some cases more virulent in recent years. As a result there have been advanced from time to time, and are being advanced, various suggestions for so-called improvements in the patent system, most of these suggestions coming from persons utterly unfamiliar with the conditions to be met and overcome.

It must be admitted that the patent system of the United States in its present form and as at present administered is susceptible of very great improvements in some of its details. The object of this article is to analyze briefly some of the conditions which have probably brought upon the patent system more criticism than others, and to show, if possible, in what directions improvements may be made.

* * * * * * *

A patent is a contract entered into between the people of the United States and the inventor. The patent does not read as a contract, but from early times it has been the well settled law that it is in force and substance such an instrument. This contract in every day language may be considered as being along the following lines: The inventor having discovered some new and useful art, machine, manufacture, or composition of matter, the knowledge of which is not available to the public, agrees on his part, to make such a full and complete disclosure of the same as

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*Class 1907. Patent Lawyer, Banning and Banning, Chicago.

will enable the public, upon the exipration of the patent, to practise the invention without the necessity of additional instruction from the inventor. Without this disclosure on the part of the inventor, the discovery would not become available to the public, except upon discovery by another inventor.

The government or the people of the United States on their part, grant to the inventor the exclusive right to his invention for a period of seventeen years or whatever the statutory period may be made, in consideration of the foregoing disclosure. It, therefore, appears that on the part of the inventor the fundamental essentials are that he shall have something which is new and useful in the proper sense, and that he shall make such a full and complete disclosure of it that its benefits may inure to the people of the United States, upon the expiration of the patent.

* * * * * * *

The Patent Office is an instrumentality not only for granting the patent, which is a mere ministerial act, but also for passing upon the question of novelty and utility of the invention. By the term utility I mean whether or not the invention is useful in any sense for the purpose intended. The one act of granting the patent is merely a ministerial act and does not require the exercise of discretion. The other act of passing upon the novelty of the invention requires the exercise of a judicial discretion, for the reason that while the details of the structure disclosed may be new, the question is at once raised as to whether or not their perfection required the exercise of the inventive faculty as distinguished from the mere application of engineering and technical knowledge.

The next point is the determination of the novelty of the invention in its broad sense—that is, assuming that certain principles or features of construction are of a patentable nature, are they novel within the requirement of the statute? If they are then the patent should be granted, but if they are not, then the patent should be withheld. The reason for this is evident because the fundamental requirements in the drawing of the contract, the granting of the patent, is that the inventor has something which was not known before, and in consideration for the disclosure of that knowledge, he is to have the exclusive right to its use for a limited period of time. One function of the Patent

Office is, therefore ,to determine and ascertain the novelty of the invention before consenting to the granting of the patent. How is this question of novelty to be ascertained?

For the purpose of ascertaining the novelty of the invention there has been built up a large corps of examiners and assistants, as well as a vast storehouse of information, classified in some form or another, so that the examiners can with comparative ease and rapidity determine what has been done along any given line of endeavor. Naturally this storehouse of information is limited to publications of various kinds wherein are made permanent records of scientific and industrial developments. Such, for example, are magazines, books, prior patents, catalogues, circulars, etc. There is naturally, and cannot be, any definite classification of those things which have been done here and there at points widely scattered throughout the country, but of which no permanent record has been made either in the form of a magazine article, or the issuance of a patent, or in some other such way. Every day the engineer is called upon to design bridges or structural details of various kinds, and the structures may be actually completed without attracting public attention and knowledge. These matters of information, however, are naturally unavailable to the examiners in the Patent Office, except in a most limited and haphazard way. There is, of course, no one who has an indefinite and unlimited knowledge of what has been done along every line of endeavor.

After the Patent Office examiners have to the best of their ability and to the best of their sources of information ascertained the novelty of the invention which it is proposed to patent, and have allowed the inventor's claims of novelty on various features, the patent may be issued and become a forceful contract or instrument between the people of the United States on the one hand, and the inventor on the other, as of the date of issue of the patent. It then enters upon a more or less rocky road of travel. It would appear that having secured the patent it should be possible to devise a means for giving it practical effect in a very simple and quick manner. It would appear that it should be possible to bring to time infringers or those who, it may be claimed, infringe, by a simple procedure and at a very slight expense. The consideration of the practical problems presented

will at once show why this cannot be done. Suppose, for example, that the owner of the patent conceives he is aggrieved by another person whom he claims is infringing. He brings suit against the supposed infringer, and we will say that upon its face it would appear that the infringement was clear. In such case it would appear that there should be no difficulty in obtaining an injunction to restrain the infringer. But the infringer unquestionably has a right to be heard and present his defense. It may be that he has been using the structure or device concerning which the suit is brought for many years without possibly the patent office having any knowledge of such fact. Possibly he has used the device widely and in a public manner in his community for many years prior to the filing of the patent application, so that he, and not the patentee, is the real inventor. In such case it would manifestly be a great injustice and hardship on the defendant to compel him to cease using that which he had himself devised long before the patentee to whom the patent had been granted. In such case manifestly the patent should never have been granted, because that fundamental essential or characteristic necessary for the grant of a valid patent, namely, the novelty of the device, or the consideration which should pass from the inventor to the public, is lacking. The inventor was not the one who first disclosed the invention, and he added nothing to the domain of public knowledge. He paid nothing to the public for the grant of the exclusive right and yet the patent was granted. Of course in such case the granting of the patent was through inadvertence or lack of knowedge on the part of the Patent Office, but for this mistake the Patent Office cannot be held blameable inasmuch as it is impossible for the Examiners to have before them all knowledge and information.

Another way to view the matter would be that if the patent were to be enforced under such conditions the property of one man would be taken forcibly and delivered to another without compensation. Such an action is, of course, inhibited by the Constitution of the United States, and is contrary to the laws of civilized peoples except as punishment for crime. Herein lies the essential difference between the American patent system and the grants of monopolies which were so odious to the peo-

ple of England and other European countries for hundreds of years. *Then* it was customary to grant a monopoly to a favored courtier or partisan, taking from the public at large something which was theirs by right and delivering it and its benefits to the favored individual. The American patent system stands on no such foundation, but rests on the broader doctrine of a contract including as its essential elements *novelty* of invention.

It will now appear that if the court were to hastily grant an injunction, we will say a preliminary injunction, enjoining the defendant from the further use of the device in controversy, without giving him an opportunity to put in his full defense, a great injustice and hardship might result without any offsetting benefit or right. Therefore the principle has long since been established in patent practice not to grant a preliminary injunction except in very exceptional cases. Those exceptions may be roughly classified as instances or cases in which the patent has once been adjudicated, that is, tested out in the courts in a regular proceeding and found to be valid, and those cases in which, by reason of special instances or relationships existing between the complainant on the one hand and the defendant on the other, it appears that the defendant is almost necessarily in the wrong. Where the patent has not been adjudicated, in other words is a "green" patent, and where no special equities exist, the heavy hand of the court should not be laid on the defendant by way of preliminary injunction.

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It, therefore, appears that in order to protect an innocent defendant from a great injustice or hardship, the patent must be litigated and tested in court. It has been urged that the burden of such procedure should be thrown upon the government—that is, on the people of the United States who granted the patent in the first place. It is urged in support of this contention that unless this is done, the patentee gains no more than he can enforce after tedious and expensive litigation. It is contended, therefore, that the burden of this expense should be borne by the government and probably administered by some governmental department. There are several possible answers to this sort of a suggestion any one of which it seems to me is sufficient to meet its forcefulness. In the first place, it is questionable in my

mind whether or not the people in this country would consent to the establishment of a great expensive department of governmental offices solely for the purpose of investigating alleged cases of infringement and commencing and prosecuting suits on behalf of the comparatively small number of owners of patents who are private individuals or corporations. Today a tendency in our democratic form of government seems to be in the direction of paternalism, but this proposition would appear to be a violent extension of that principle. It would seem that this extension of paternalism in our government would be a far greater one than any individual step which has so far been taken. In the first place, this arrangement would undoubtedly necessitate the establishment of a large corps of men at comparatively high salaries for the purpose of investigating charges of infringement and instituting and prosecuting suits where they seem to be well founded. The patentee in each case would be largely at the mercy of this department in instituting the suit, because the department might refuse to commence suit even when the patentee himself felt reasonably certain of sustaining his charge. In the second place, the amount of litigation which would thus be instituted or built up would be of tremendous volume. Inventors with frivolous claims of infringement would be constantly demanding attention, and would undoubtedly be constantly chagrined and disappointed at the refusal of the department to prosecute their suits. But it seems to me the main objection would be that the great industries or corporations of the country would be the most benefited by any such arrangement. The criticism at the present time is that the small inventor does not have an equal opporunity with the large corporation, but that is only to be expected in this line of endeavor as in every other. It is, of course, true and always will be, that the man or corporation capable of commanding resources or credit has an advantage over the one who does not have such resources. Such companies as the General Electric Company and the Westinghouse Electric & Manufacturing Company, which at the present time probably institute and prosecute large numbers of suits, would, of course, be the first to benefit by eliminating the expenses of maintaining a department for the handling of this class of work.

But there is another reason which it seems to me is more

easily understood by the layman why such an arrangement should not be adopted, particularly in the case of the patent system. If it should be the duty of the government which grants a patent for invention to institute and prosecute suits on behalf of the owner of a patent, why should it not likewise be the duty of the government to institute and prosecute suits on behalf of grantees of land or other species of private property? Title to land in this country in a great majority of instances devolves in the first place from the government, and this is particularly true in the Central and Western states where the lands have originally been a part of the public domain, and have been parcelled out to homesteaders and others by land patents. Litigation is constantly arising and being prosecuted for the protection of the owners of the land, for the protection of their titles to it, and for the prosecution of tort-feasors, those who are trespassing on the land without proper warrant or license. Why should it any more be the duty of the government to prosecute those who trespass upon the rights granted by patents of invention than it should be the duty of the government to prosecute those who trespass upon real estate which also is granted by the government. It is well recognized that the duty of preventing or stopping trespassers on personal property is and should be carried by the owner thereof, and a patent of invention is no more nor less than a species of personal property.

It has been suggested that the grant of the patent should be coupled up with some sort of requirement, whereby the owner thereof would be required to work his invention within a certain time limit after the patent granted. This suggestion follows largely from the fact that such requirements are inserted in foreign patent grants, and, of course, the suggestion is based on the assumption that inventors are more efficiently protected by the grant of foreign patents than they are by the grant of patents in this country. I think that this proposition may be very easily refuted in either of two ways. First, I deny that the grant of a foreign patent carries with it more real protection than does the grant of a United States patent. Statistics will show that a larger percentage of patents granted by Great Britain are declared void for on reason or another than were declared void in legal proceedings in this country. Germany, where the grant

of the patent is coupled with a working requirement, and which has a system very similar to that of the United States for the examination of the application before the grant of the patent, is probably the one country where industrial development has reached as high a state of perfection as has been reached in this country. And yet even in Germany it is not necessary for the inventor to work the invention in Germany if he be a citizen of this country, and if he be manufacturing the device in this country. The bars have been let down very materially in Germany as in certain other countries on the question of compulsory working in order to maintain the validity and forcefulness of the patent. I contend that the provision of the working requirement in a great majority of patents would work a far greater hardship on the small inventor that it would on the large corporation because ordinarily the small inventor has a hard enough time any way trying to raise capital to exploit and develop his improvement, if it be an improvement.

It is contended that the small inventor ordinarily encounters too many obstacles in the development and merchandising of his improvement. This, however, is only the natural result of the circumstances in which he may be placed, and is not a fault of the patent system. It ceratinly cannot be claimed that it should be the duty of the government to undertake the manufacture and development of inventions—this would be a most unwarranted and obnoxious invasion of the field of private endeavor. The difficulty in this regard lies with the inventor himself, and is not traced directly to any fault of the patent system. Too many men suppose that the mere conception of the idea of a thing, and the grant of a patent to protect it, will in and of itself bring wealth and leisure. Some inventors are not entitled to any sympathy because it is only by the expenditure of energy and thoughtful endeavor that industries can be developed. Ideas without practical energy and foresight do not and never will bring into existence great commercial and industrial organizations.

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The foregoing discussion brings us to a consideration of the reason why large industrial concerns very seldom pay large remunerations or sums for the purchase or license of patents. We

sometimes hear of the sale of this invention or another for some fabulous figure, but in a great many instances such statements are either absolute falsehoods or are coupled with some condition or another which very largely removes their forcefulness. The percentage of inventions and patents which are sold for any extraordinary large amount is so small as to be negligible in the sum total. Why is this? The answer is perfectly apparent and is simply that it requires more than an idea to bring into being a large and profitable industrial organization with its myriad of details, with is superintendent of manufactures, its superintendent of sales, its traveling men, mechanics, purchasing department, and a hundred and one other details which are frequently overlooked in its general survey. It requires more than the dreamy idea of an abstract thinker to bring these things into effect and life. It requires the practical business foresight and ability of the business man to accomplish these things, as well as the ability to raise and handle profitably the necessary amount of capital. Too often the inventor conceives that he has revolutionized some field of endeavor and thereupon demands a large consideration for the use of his invention, something far in excess of what the invention is really worth, forgetting that after the capitalist or business man has invested his money in the invention itself he has only made one investment out of a large number which will be necessary before a return can be made on the total investment.

What then can be done to improve the patent system? In the first place eliminate the man who holds out false hopes to the inventor misleading him into the belief that large returns will come to him without effort on his part, which on the contrary will require great effort and expenditure of time.

In the next place stiffen up the requirements as to the nature of improvement necessary before a patent will be granted. Throw a heaveir burden on the inventor to show that he has really made an advance in his art, so that when the patent is ultimately granted, it will carry a greater presumption of validity.

Finally, give the patent greater effectiveness after it has been issued. I have shown that this cannot be done in some ways without danger of working great injustice to innocent defendants. It can, however, be done by simplifying and improving and expediting court procedure. Make the trial of a patent

case as simple as possible considering all of the circumstances surrounding it, and considering the nature of the proof which must be adduced, and eliminate as far as possible the delays and expense incidental thereto. A great advance has probably been made in this particular line within the last two years by the promulgation of the new rules of procedure in the equity courts of the United States which were promulgated by the Supreme Court of the United States some two years ago. These are the practical ways to improve the patent system without running great danger of introducing into it elements which may work to its detriment. I suppose there has not been a time within the last 20 years when there has not been pending before Congress one or more bills supposedly for the improvement of the patent system. Most of these fall of their own weight, it appearing that the fundamental ideas on which they stand are fallacious. Others have been rejected after more careful scrutiny and after extensive hearings by the proper committees in Congress. I submit that before entering upon any radical changes in our patent system we should be very certain that they will act to benefit it, bearing in mind the rights of the small inventor, as well as of the larger corporation. But it would seem that the greatest benefits can probably be and probably will be secured by the simplification of court procedure, which, as I have above stated, has been very large accomplished within the last year or two.

THE SPITZGLASS COMPUTER FOR THE FLOW OF FLUIDS IN PIPES

BY A. H. ANDERSON *

Students and graduates of the Armour Institute of Technology will be interested in knowing that one of their classmates, Mr. J. M. Spitzglass, 1909, is the inventor of a computer for the flow of fluids in pipes, which has attracted attention from many directions. The feature of this device is that it solves the complicated formulas involving loss of pressure head, diameter, coefficient of friction, specific gravity, and length, giving the result directly without the necessity of making computations on paper.

It is made in slide rule form which makes it perfectly applicable to any length of pipe, any diameter, any specific gravity, and any pressure drop. Fig. I, shows the rule in use. Fig. 2, shows

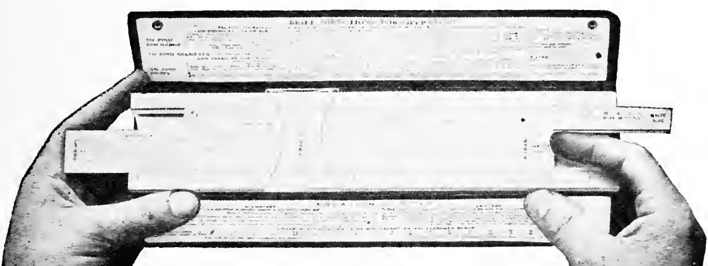

Fig. 1.

the scales in greater detail from which it will be seen that the logarithmic divisions are used and therefore all ordinary calculations for multiplication and division are possible. It is possible to make computations with this rule for the flow of air and gas of any pressure and any specific gravity, and also steam and water.

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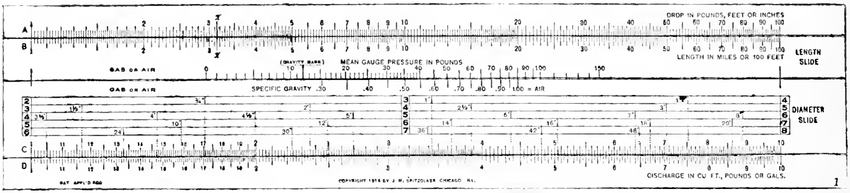

Fig. 2.

Low Pressure Gas and Air.

It is instructive to follow through the derivation of the formula involving the data mentioned above for low pressure gas and air. The starting point is Chezy's equation, which is

$$h = \frac{4 \times f \times l}{d} \times \frac{V^2}{2g} \quad \ldots\ldots\ldots \quad (1)$$

where h is the loss of pressure head in feet of the fluid considered,
f is the coefficient of friction,
l is the length of the pipe in feet,
d is the diameter of the pipes in feet,
v is the velocity in feet per second
solve Eq. (1) for v.

$$v = \sqrt{\frac{2gdh}{4fl}}$$

Let D be the diameter of the pipe in inches,

$$\text{Then } d = \frac{D}{12}$$

$$\text{and } v = \sqrt{\frac{2gDh}{4 \times fl \times 12}}$$

$$= 1.16 \sqrt{\frac{Dh}{fl}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where the flow is measured in cubic feet per hour

$$Q = \frac{\pi}{4} \times \left(\frac{D}{4}\right)^2 \times 3600 \times v \quad \ldots\ldots\ldots (3)$$

Substitute the value of v from eq. (2) in eq. (3),

$$Q = \frac{\pi}{4} \left(\frac{D}{12}\right)^2 \times 3600 \times 1.16 \sqrt{\frac{Dh}{fl}}$$

$$= \frac{\pi \times 3600 \times 1.16}{4 \times 144} \times \sqrt{\frac{hD^5}{fl}}$$

$$= 22.8 \sqrt{\frac{hD^5}{fl}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

The value of f as determined by Spitzglass' experiments which have been unusually painstaking is

$$f = .00325 \left(1 + \frac{3.6}{D} + .03D\right)$$

Substitute this value of f in eq. (4),

$$Q = \frac{22.8}{\sqrt{.00325}} \times \sqrt{\frac{hD^5}{l\left(1 + \frac{3.6}{D} + .03D\right)}}$$

$$= 400 \times \sqrt{\frac{hD^5}{l\left(1 + \frac{3.6}{D} + .03D\right)}} \quad \ldots\ldots\ldots (5)$$

In low pressure gas measurement the value is usually given in inches of water. The relation between h and inches of water is given as follows:

$$\text{ft. of gas} = \frac{\text{lbs. per sq. ft.}}{\text{density of gas}} = \frac{\text{In. of water} \times \frac{62.4}{12}}{w \times .076}$$

$$= \frac{\text{In. water} \times 70}{w} \qquad \ldots\ldots\ldots (6)$$

Where w is the density of the gas referred to air as unity. If air itself is being considered, then,

ft. of air = In. water $\times$ 70

Now, substitute (6) in (5),

$$Q = 400 \times \sqrt{\frac{HD^5 \times 70}{wl\left(1 + \frac{3.6}{D} + .03D\right)}}$$

$$= 3350 \times \sqrt{\frac{HD^5}{wl\left(1 + \frac{3.6}{D} + .03D\right)}} \qquad \ldots\ldots\ldots (7)$$

where H is the drop of pressure in inches of water.

Compressed Air Formula

Repeating eq. (5)

$$Qa = 400 \times \sqrt{\frac{hD_5}{1 + \frac{3.6}{D} + .03D)}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

now, $h = \frac{p}{y_a}$

where p is the pressure drop in pounds per square ft.

and y_a is he average density of air in the pipe (the density being a maximum at the inlet and minimum at outlet)

and also let p=144P where P is the pressure drop in pounds per sq. in.

Substitute in (5),

$$Q_a = 400 \times \sqrt{\frac{144\ PD^5}{y_a l\ (1 + \frac{3.6}{D} +).03D)}}$$

also $$Q_a = \frac{14.7\ Q}{A}$$

and $$y_a = \frac{8A}{14.7}$$

Where Q_a is the equivalent flow at average pressure A,
Q = flow reduced to standard condition.
A is the average pressure in pipe line, in lbs. per sq. in.,
y is the weight of 1 cu. ft. of the gas at standard conditions.

$$\text{Then } \frac{Q \times 14.7}{A} = 400 \sqrt{\frac{144\ PD^5}{\frac{8\ Al}{14.7}\ (1 + \frac{3.6}{D} + .03D)}}$$

$$Q = \frac{400 \times \sqrt{144}}{\sqrt{14.7}} \sqrt{\frac{PAD^5}{yl\ (1 + \frac{3.6}{o} + .03D)}}$$

also $y = w \times .0761$

Where w is the density of the gas or air referred to air as unity. In case air is being transmitted w will be unity.

$$\text{Then } Q = \frac{400 \times \sqrt{144}}{\sqrt{14.7} \times \sqrt{.0761}} \times \sqrt{\frac{PAD^5}{wl\ (1 + \frac{3.6}{D} + .03D)}}$$

$$= 4500 \times \sqrt{\frac{PAD^5}{wl\left(1 + \frac{3.6}{D} + .03D\right)}} \quad \ldots\ldots\ldots \quad (8)$$

Eq. (7) is the formula, then, for low pressure gas or air, while eq. (8) is the equation for high pressure gas or air. The difference between the formulas is only that in the low pressure formulas the assumption is made that there is no change of density. A gas is considered "low pressure" if under a compression of less than 12 inches of water.

These equations are formidable and require considerable patience and some skill for solution. It is the office of the Spitzglass computer to give these solutions without the necessity of actually going through the calculations.

Attention is called to fig. 2, which shows that there are two slides, one (the length slide) containing a length scale and a mean gauge pressure scale; the other (the diameter slide) containing the specific gravity scale and also the diameter marks set in horizontal rows. In the middle of the diameter slide and also at each end are columns of figures in heavy type. In general, the heavy type figure in the middle column in the same row with the diameter indicates the number of integers in the cubic feet per hour.

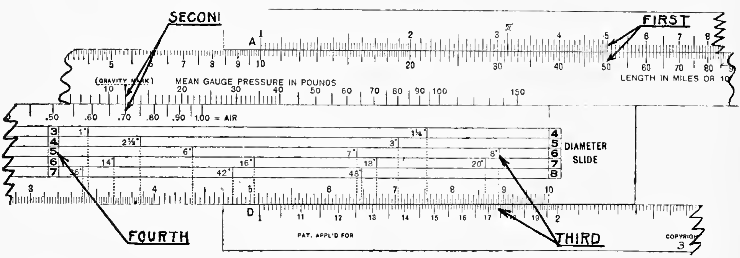

Fig. 3.

To illustrate the use of the computer two problems are given. Example one. Find discharge of gas in cubic feet per hour of

an eight inch pipe, with a drop of 5 inches of water over a length of 5000 feet, the specific gravity of the gas being 0.70. Referring to Fig. 3:—

First,—set 50 (the length is used in units of 100 feet) on length scale to 5 inches on drop scale.

Second,—Move diameter slide until 0.70 on specific gravity scale is set to gravity mark on mean pressure scale.

Third,—Read on discharge scale, under 8 inch diameter line, the number 1.74.

Fourth,—In the middle heavy type column on the diameter slide find the figure "5" in the horizontal row on which the 8 inch diameter is marked. The answer is therefore 17,400 (five integer places) cubic feet per hr.

The problem might have been reversed and a solution obtained. For example, the discharge in cubic feet per hour might be given, also the diameter of pipe, length, and specific gravity, to obtain the drop of pressure in the given length, in which case the steps would be taken in the reverse order.

Example 2. Find the drop of pressure in a 10 inch pipe delivering 100,000 cubic feet of gas over a length of 1,200 feet, specific gravity of the gas being 0.65.

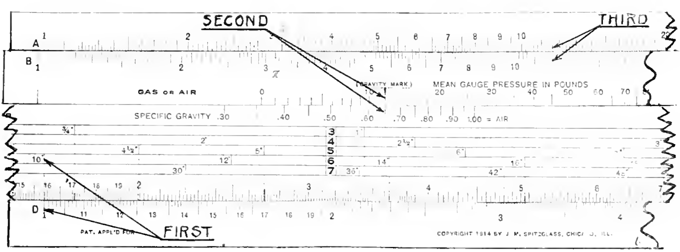

Fig. 4.

Referring to fig. 4.

First—set 10 inch diameter line to 100,000 (1 read with 6 integers) on the discharge scale.

Second—Move the length slide until gravity mark coincides with 0.65 on the specific gravity scale.

Third—Over 12 (1200 feet) on length scale read on drop of pressure scale 11.55 inches of water which is the required answer.

Attention is drawn to the fact that when substituting in the foregoing equations the diameters of pipes must be the exact diameters. A pipe which is nominally 1 inch in diameter in reality is somewhat larger. The computer takes this discrepancy into account, and it is simply necessary to consider the nominal pipe diameter when using this instrument.

SOME MECHANICAL FEATURES IN THE NEW COOK COUNTY HOSPITAL

BY H. A. DURR*

The tax payers in Cook County maintain a large group of Hospital Buildings at West Harrison and Lincoln Streets in the City of Chicago that very few of us know much about, excepting what we read in the newspapers from time to time, and since the County has recently appropriated $3,000,000.00 for the building of a new hospital, it is of considerable interest to know what this sum has been spent for.

For many years a group of hospital buildings has existed on the property bounded by West Harrison, Wood, Polk and Lincoln Streets and more recently a Detention Hospital, two Tuberculosis Hospitals, a Children's Hospital and a Contagious Hospital have been erected. The older buildings are devoted to general hospital work, and the entire group exclusive of the five new buildings just mentioned, will accommodate approximately 500 beds. The Contagious Hospital will accommodate approximately 200 beds, the two Tuberculosis Hospitals 350 beds, the Children's Hospital 100 beds, and the new Detention Hospital approximately 240 beds, making a total of 900. The entire new Cook County Hospital, which is now being completed, will accommodate 970 beds for patients and 71 beds for internes. This data is given so that one may gain an idea of the magnitude of this one new hospital building, which is being erected at the north end of the property along West Harrison Street, and from the figures one can see that the new institution is more than equal in capacity to the entire old group or the group of five buildings, which have been erected within the last six years.

The main portion of the New Cook County Hospital is 560 feet long on Harrison Sreet and when it is completed there will be four wings equidistant from each other and extending back a distance of approximately 200 feet. The Hospital building is eight stories high, is built with a basement pipe space approximately 6 feet in the clear instead of a full height basement and

*Class of 1905. Mechanical Engineer with the County Architect.

an additional pipe space approximately 5 feet in the clear between the 6th and 7th floors. In the center portion of the main building, the pipe space has been excavated to a much greater depth to accommodate the switchboard, pumps a other machinery. The entire building is of fireproof construction and has been built with an extensive elevator equipment and a novel dumb waiter equipment besides special air washing and air cooling devices. The main portion of the hospital building is now practically complete and occupied, and only two of the four wings are in course of construction. These two wings will be finished by Dec. 15th, 1914, and the erection of the two additional wings will probably be authorized soon afterwards.

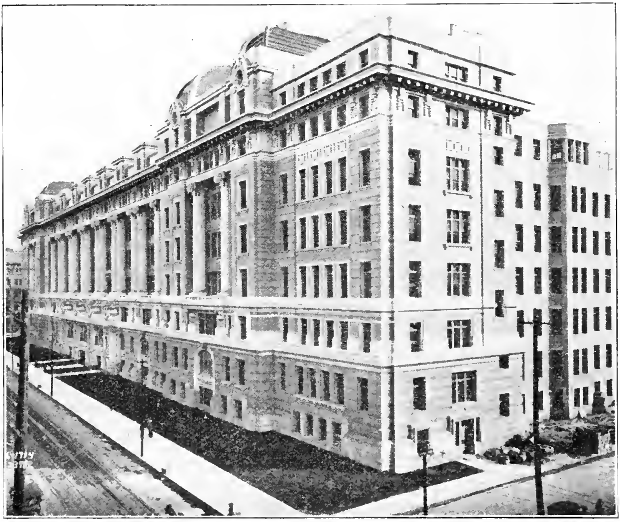

Fig. 1. The New Cook County Hospital.

The hospital is arranged in general to accommodate patients in wards rather than private rooms, and at the rear portion of each of the wings on each floor, provisions have been made for

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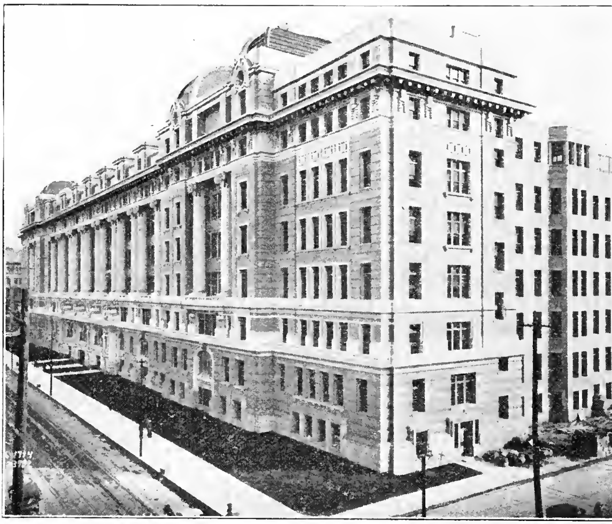

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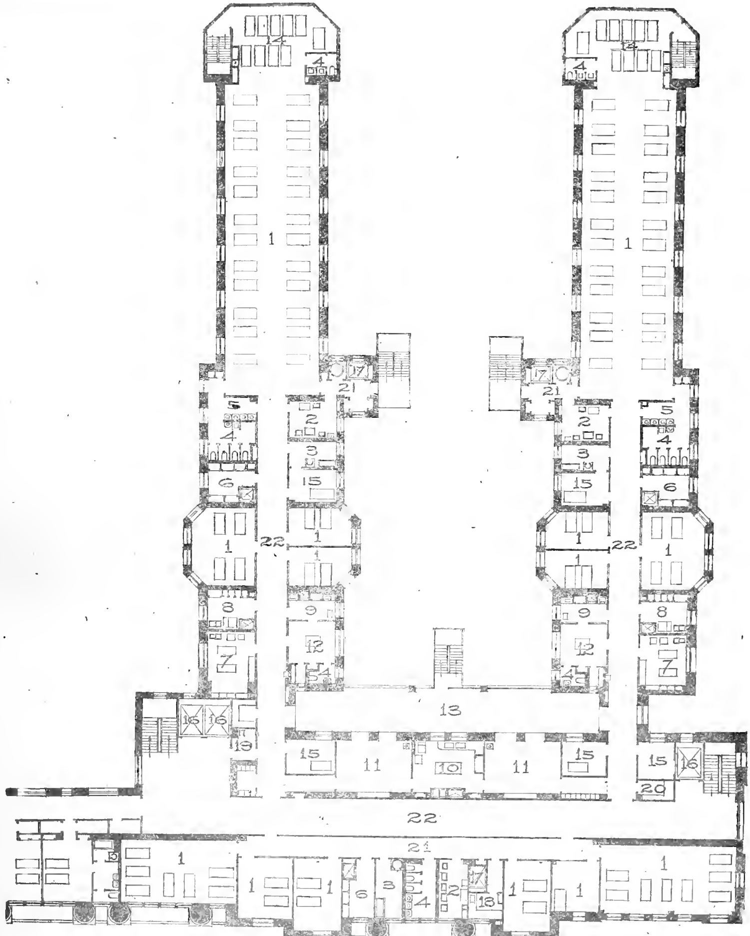

Fig. 2. Cook County Hospital—Plan of Pavilians.

1, ward
2, utility room.
3, bath room.
4, toilet.
5, wash room
6, linen room.
7, dressing room.
8, diet kitchen.
9, medicine closet.
10, serving panry.
11, dining room.
12, nurses' room.
13, porch.
14, solarium.
15, quiet room.
16, passenger elevator.
17, freight elevator.
18, laboratories.
19, mop closet.
20, surgical appliance closet.
21, passage.
22, corridor.

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a 24 bed ward. At the extreme south end of each wing, a solarium has been constructed which will be used by the patients during the time they are convalescing. That portion of each wing, which is nearest to the main building, accommodates the service rooms.

Each of the wings referred to above are six stories in height and are erected complete with utility rooms, drug rooms, toilet rooms and serving pantries on each floor besides elevator service and clothes chute drops. The hospital throughout has been designed on a unit basis, that is, portions have been made complete in themselves with the exception that the operating is all done in one section of the building, and the food is prepared in a kitchen outside of the building and carted in to small distributing kitchens.

The accompanying diagrams show the construction of the hospital in general, but there are many features that are worth describing. In figure No. 2 a portion of the corridor near the fire escape has been marked No. 21, and a clothes chute is located in this space which deserves mention. This clothes chute is cylindrical in shape, built of steel and lined with glass. It has door openings at each floor so that soiled linen may be thrown in at any floor level and dropped to the basement, where it is collected and carried to the laundry. This chute is provided with a ventilator at the top so that it always contains fresh air and in addition a spray pipe is located above the top floor opening so that the entire chute can be flushed out with warm water at any time it is necessary to cleanse it. With this scheme the soiled linen can be handled quickly without any of it being carted through the main corridors of the building.

Three dumb waiters rise vertically through rooms 6, 8 and 9 in each wing. Linen is carried on one to room No. 6; drugs are carried on another from the main drug room up to room No. 9 and on the third dumb waiter food is carried to the different diet kitchens marked room No. 8. These three elevators in each wing, with a similar equipment in each of the other wings, are controlled from one central point, and it is impossible to operate these cars excepting through the main control board on the first floor. In case a person on the third ffoor wishes to receive certain drugs, he telephones to the drug room for his re-

quirements, and after the prescription is filled the drug clerk phones to the dumb waiter switchboard operator giving full directions as to the point to which this particular medicine is to be delivered. In this way, there is no confusion about the handling of the dumb waiter apparatus, for the entire supervision is under the care of one man, who operates all the machines by a series of push buttons. The push buttons for each dumb waiter are mounted on a switchboard in vertical rows and by pushing the button marked 3d floor, a certain dumb waiter will run automatically from the position it was in at the time the signal was received to the third floor level. With such an equipment the chances for accidents are reduced to a minimum and when there are three or four calls in at the same time, the switchboard operator can decide which demand is most urgent and use the car for that purpose first.

The elevator equipment is electrical throughout, and machines are controlled by operators in the cars. No push button elevators have been installed in this institution. A portion of the elevators in the main building have been designed for passenger service while those in the wings are in general used for the handling of freight. Both drum and traction type elevator engines have been used in the institution.

The heating system is of the two-pipe vacuum type, with an overhead or attic supply main, but it has been put in according to standard practice and contains no special features. Large ventilating fans and air washers have been installed in conjunction with the heating apparatus to provide fresh washed air in various portions of the building and another group of exhaust fans carry the vitiated air out of the building. The fresh air fans are located near the rear end of the wings on the first floor, and the exhaust air fans are located on the upper floors. The hospital building is open on all sides so that it can be well ventilated even though the fan equipment is out of order due to breakdown and not available for service.

The hospital is provided with city telephone service at numerous points, and a complete nurses' signal system by which a patient can attract the attention of a nurse by pressing a button attached to an extension cord which is located near the bed. To summon a nurse, a patient sends in a call, which lights a lamp over the door leading to that particular room in addition to

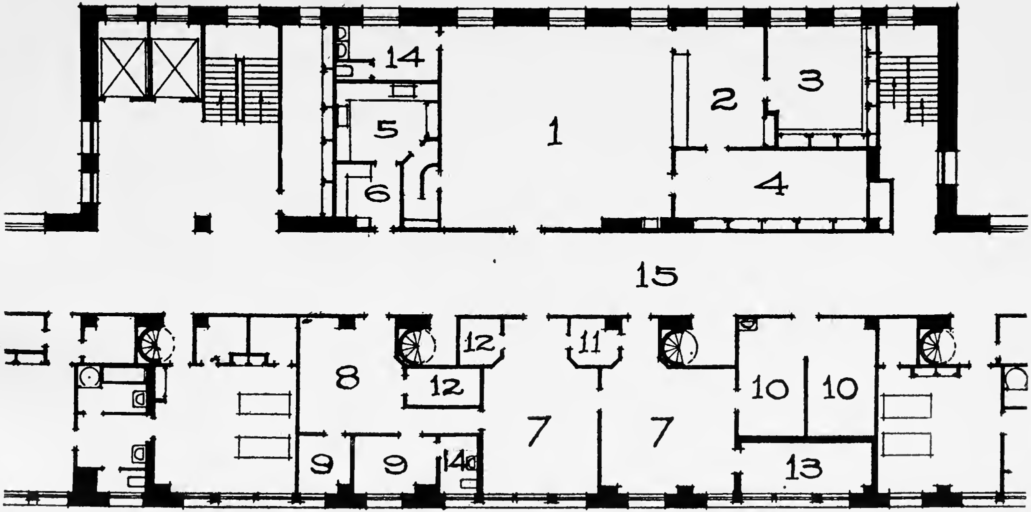


Fig. 3. Cook County Hospital—Radiographic Suite.

1, waiting room.
2, office.
3, library.
4, consultation and exhibition room.
5, dark room.
6, supply room.
7, radiographic room.
8, fluorographic room.
9, preparation room.
10, treatment room.
11, operator's room.
12, instrument room.
13, generating apparatus room.
14, toilet.
15, corridor.

another lamp located in the supervising nurses' station, and in case the floor nurse does not respond to this call promptly, the head nurse will know of the fact because of the lamp being lit on the supervising panel an extremely long time. The lamps on the system always remain lighted until a call has been answered and the nurse has pressed a reset button at the head of the patient's bed. In this way it is always necessary for the nurse to respond to the calls for they cannot extinguish the lamps until they have pressed the reset button at the head of the patient's bed, and if these lights remain burning for some considerable time the head nurse is aware of the fact because of the supervision station, and she can call on her subordinates to learn of the delay.

The ice boxes throughout the hospital building are refrigerated by means of brine, which is circulated from a cooling tank in the basement of the hospital building through a piping system which connects with all the boxes. The brine is cooled by means of a 50 ton carbonic anhydride compressor, which is direct connected to a 75 H. P. motor. After the brine has circulated through the ice boxes it is collected in a pipe header and run through a cooling coil in conjunction with the air cooling system, which supplies the operating rooms only. From here the brine is carried back to the cooling tank and again chilled before being sent out through a similar cycle of operation. This air cooling system is employed in practically all of the higher class hotels of today, and is considered an important feature in the operating rooms, where it is extremely difficult and nauseating to work on hot summer days. The drinking water throughout the building is cooled by means of this refrigerating system after it has first passed through some large quartz filters.

The steam, electric light and power service is supplied to the new hospital by a power plant, which has been on the grounds for some time. A three-wire 220-110 volt direct current system is used for all electrical equipment including the X-Ray or Radiographic suite shown in Fig. 3.

Two 8-sweeper motor driven vacuum cleaning machines have been installed on the first floor of the hospital building and each connects with a system of risers located at convenient points so each machine serves one-half the building. Outlets are located on these vacuum risers at each floor level and they are so in-

stalled that no more than 60 feet of hose need be used at any one time to clean the most remote portions of the building. It is extremely objectionable to have long lengths of hose lying on the floor especially in a hospital where patients are using invalid chairs in the corridors and wards.

Sterilizing equipment has been provided on every floor in the various portions of the building to supply the local demands of each wing. In room No. 2, (Fig. No. 2) in each of the wings a dressing sterilizer, instrument sterilizer and utensil sterilizer will be provided to care for the demands of that section. A central water sterilizing equipment will be provided for sterilizing and delivering hot and cold water to the operating portions of the building, and this water will be conveyed in piping which is lined with block tin.

A fire alarm system has been installed throughout the building and an alarm can be sent from any one of eights points on each floor, and this call is received at the telephone switchboard on the second floor, in the engine room in basement, and at the superintendent's desk so that a response can always be made in a minimum of time. The telephone switchboard operators can quickly warn all nurses in portions of the building adjacent to the sections which may be on fire and by employing this scheme there would be no excessive noise or disturbance, and but little chance of a panic which, of course, would be extremely dangerous in a hospital.

A clock system has been installed with a master clock in the superintendent's office and approximately two secondary clocks have been distributed throughout the hospital. These secondaries receive an impulse through electric wiring from the master clock each time a minute period has elapsed. Clocks have been located in practically all of the wards, the operating rooms, utility rooms and the offices.

Special attention has been given to reducing the noise caused by rotating machinery, to a minimum by placing elevator and dumb waiter machines, ventilating fans, and practically all other motor driven machinery on thick hardwood frames set on the floor, provided with a 2″ layer of compressed board cork and a 1″ layer of solid felt on top. These shock absorbing pads are placed under the full area of the machinery and heavy founda-

tions have been provided in every case where it is possible, so as to minimize the chance of vibration.

The operating rooms are located on the 7th floor, and there are nine in all, two of which are provided with amphitheatres for the use of students and visiting surgeons. The seven smaller operating rooms are 21 feet long by 17 feet wide and each is arranged so as to be complete with anaesthetizing, sterilizing, wash and plaster rooms adjoining. In each of the small operating rooms special attention has been given to the illumination. Large windows have been provided which terminate in sloping skylights, which extend slightly above the roof and these all face in a northerly direction so that the direct rays of the sun will never shine in the operating rooms. The windows are approximately 16 feet wide and 18 feet high including the skylight portion. At night the doctors wish to have the same lighting effects that they become accustomed to during the day time and to accomplish this in the greatest possible measure a series of metal troughs has been placed in the ceiling with light units spaced on 12″ centers. These light units are provided with high grade reflectors and are so set in place that they point toward the operating table, which has been located in the center of the room. Four metal troughs are used and set in the ceiling in the form of a rectangle with the lower surface flush with the ceiling plaster. Each trough is 12″ by 14″ in cross section; two of them 8 feet long and the other two 12 feet long. With this scheme of lighting it is practically impossible for the doctors or nurses to cast a shadow on the operating table, for the light emanates from a great number of sources all of which are directed toward the center of the operating table. The trough in which the lights are placed, is provided with hinged frames on the lower side in which a special prism glass is set. With these fixtures there is no chance for dust or dirt to collect and drop onto the table at any time and especially during an operation.

The new hospital building is entirely distinct from all others on the premises with the exception that it is served by the old kitchen and laundry, and the steam and electric connections run through underground tunnels from the old power house located about the center of the lot. The site for the entire group of County Hospital Buildings is about 600 feet wide and 900 feet

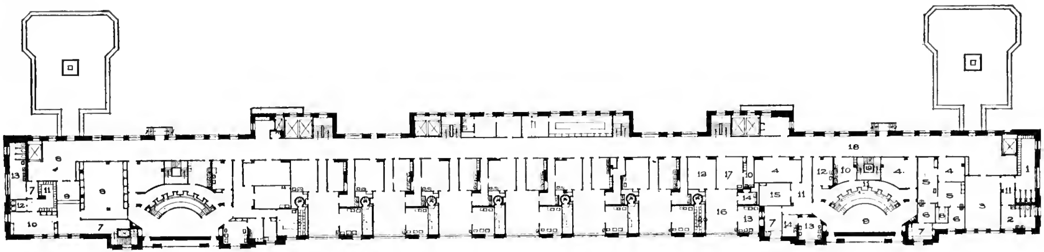


Fig. 4. Cook County Hospital—Operating Department.

1, doctors' locker room.
2, doctors' toilet room.
3, surgeons' library.
4, waiting room.
5, examination room.
6, treatment room.
7, laboratory.
8, supplies.
9, clinic.
10, doctors' scrub room.
11, passage.
12, etherizing room.
13, sterilizing room.
14, nurses' scrub room.
15, dressing room.
16, orthopedic operating room.
17, plaster room.
18, corridor.
19, students' chair.
20, students' balcony.

long and the new Hospital containing 1,041 beds when all four wings are complete, covers only one-fourth of the property so the ultimate aim of a 3,000 bed institution can be easily attained.

Only a few of the details have been described, but from this data one can gain some idea as to the completeness and suitability of the new Cook County Hospital for the purpose it was intended.

THE ELECTRIC FUSE FOR ORDINARY OPERATING VOLTAGES

BY G. W. BORST*

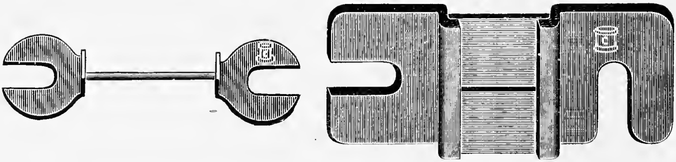
While it forms a part of practically every electric circuit and is one of the most common pieces of electrical apparatus, the fuse is not usually given much thought by the electrical engineer. This is probably due to its seeming simplicity and to the fact that it may be secured, with its cutout or mounting base, in a form complete and ready for use—its needs no adjustment and has no moving parts. On this account a brief review of the principal features of design, construction and operation of fuses ordinarily used for 250 and 600 Volt circuits may be of interest to readers of the Armour Engineer.

One striking difference between the steam or gas engine and the electric motor as a source of power is that either of the former when heavily overloaded will refuse to operate, while the latter, in most of its forms, if the current supply remain uninterrupted, will continue, probably to its own injury. The damage usually results from heat, caused by the excessive current, burning out insulation or connections and causing short circuits, grounds or open circuits. Early electrical workers discovered that the most natural remedy was to so weaken some portion of the electric circuit that it would melt open or fuse before the danger point to the apparatus was reached. Thus the electrical fuse was a natural and necessary development and its present wide-spread use is a measure of its importance.

In form there are several varieties, including, for ordinary voltages, the open link fuse, the enclosed fuse and fuses stamped from aluminum, copper or other sheet metal; and for high voltages the expulsion fuse or other special types. For present purposes only the first two need be considered, as they include by far the greater number in daily use. So extensively are these two types, the open link and enclosed fuse, employed, that the National Board of Fire Underwriters have found it wise to reduce the fire hazard accompanying improperly designed fuses by prescribing, in the National Electrical Code, certain standards of

*Class of 1904. Electrical Engineer, Chicago Fuse Mfg. Co.

size, construction and operation. For the open link fuse, these include minimum break distances, and for the enclosed fuse, standard dimensions and certain operating requirements.



Types of Open Link Fuse Used for 50 and 1000 Amps. Respectively.

From the use of a piece of wire of the same material but smaller than the balance of the circuit and which would therefore be the first to open, experiment lead naturally to the discovery of a metal which would open more readily and at lower temperature than copper. Then, instead of winding the fuse wire about the screws or binding posts, it was found to be better, both in appearance and operation, to solder copper terminals to the fuse wire. This produced the open link type of fuse, which was formerly in very extensive use but is now ordinarily restricted to such locations as on the rear of switchboards, or in closed boxes of metal or other non-combustible material, where the throwing off of metal can do no harm. To guard against the use of improperly short lengths of the fusible portion, the National Electrical Code specifies the minimum distance between the blocks upon which the fuse is to be mounted or between the terminals themselves if they are closer than the blocks—the distance varying as follows:

Amp.	125 Volts	25 Volts
0- 100	3/4 in.	1 1/4 in.
101- 300	1 in.	1 1/2 in.
301-1000	1 1/4 in.	2 in.

It is necessary that the terminal should be of ample thickness and contact area to properly care for the current. In practice the capacity allowed is usually 150 to 200 amperes per square inch of the surface, taken on one side of one terminal, if the latter is not immersed in oil or favored by exceptionally good ventilation. While experiments have tended to show that the cur-

rent carrying capacity of contact surfaces depends upon the contact pressure, it is not safe to depend upon clean contacts and extremely heavy pressure, since allowance must be made for careless installations and the above limits should not ordinarily be exceeded. If the terminal is too small it will heat unduly and cause the fuse to open prematurely, or even to weaken at the point where the terminal is attached to the fusible strip.

Type B. 3 to 60 Amperes.

Type E, 61 to 1000 Amperes.

The enclosed fuse was developed as a means of overcoming the hazard incident to the open fuse. The principle of the Code requirements are that they shall carry their rated current (the number of amperes stamped on the label) without a rise in temperature at the outside of the tube of more than 125° F. when tested under the prescribed conditions; they shall carry indefinitely 110% of their rating; and on 125% shall open without reaching a temperature that will injure the fuse tube or terminals of the fuse block. On 150% they shall open within a certain time, varying from one minute to fifteen minutes, according to the size of the fuse. They shall also open on short circuit currents without holding an arc, or throwing out melted metal or suffiicient flame to ignite easily inflammable material. These requirements were adopted in 1905 and apply to 250 volt fuses from 0 to 600 amperes and to 600 volt fuses from 0 to 400 amperes. Above these sizes, it was considered unwise to standardize single. Two approved sizes may, however, be used in parallel. Most of the manufacturers will also furnish enclosed fuses, type E, as high as 1,000 amperes, designed in proportion to the 0—600 ampere capacities, and in limited capacities, some manufacturers list them for as high as 22,000 volts.

Types known as "A" and "C" are occasionally used and may be secured up to 600 amperes. The construction of these is shown in the illustrations. The type "A" has the advantage of a screw clamp contact and formerly was in very common use, but the type "C" is less satisfactory on account of the dif-

ficulty in securing perfect contact against the flat sides of the terminals.

Type A.

Type C.

Those who have watched a fuse of the N. E. C. Standard type under a moderate overload, as it quietly opened the circuit, without any particular demonstration, may not realize that it is performing its duty under the least trying of circumstances. If some accident, or the failure of insulation in the apparatus, were to produce a short circuit, the Fuse would be required safely to break a current not 25% or 50% above its rating, but probably one hundred per cent greater. While this condition is of rare occurrence as compared with the former, it is one of much greater danger and the fuse must be designed to meet it, otherwise the protection sought is lacking and the fuse becomes an added risk instead. This applies particularly to the enclosed fuse, which is the most common form, and did electricians and those in charge of electrical machinery but realize the fact, there would be fewer substitutes and cheap make-shifts used in place of those approved by the Underwriters. To properly grasp the condition it must be understood that when an enclosed fuse fuse opens on short circuit the heat due to the I^2R loss, on account of the abnormal current, it is so great that the conductor or element is not simply melted but is vaporized almost instantly. Since the volume increases greatly when passing into the gaseous state, the pressure on the inside of the fuse increases to many pounds per square inch, and the casing must be strongly constructed to withstand the strain. If it is blown open, sufficient fire may be emitted to ignite surrounding material.

The purpose of the white powder used in most fuses is to fill the air space with a substance which will expand but little when highly heated and which will also absorb and cool some of the vaporized metal, thus lessening the internal strain on the fuse shell. Such substances as fine sand or marble dust are

wholly unsuited to this work, since they have a tendency under short circuit conditions, to melt into a slag and to become a conductor. The fillings used by most of the manufacturers are specially prepared and are the result of long and painstaking experiment.

It will be readily seen to be important that the volume of metal be as small as possible, also that the vapor be a relatively poor conductor of the electric current. The ordinary alloy fuse wire or strip is thus not well adapted to this work on account of the amount of metal involved, nor, on the other hand, is copper wire suitable, because of the relatively high conductivity of its vapor. With the latter—on account of the high temperature attained by copper before fusing—it would also be difficult to prevent injury to the tubing were the fuse gradually overloaded to the blowing point.

There is perhaps more engineering skill needed in the design of a satisfactory enclosed fuse than is apparent to him who uses it but has never had occasion to make a thorough study of the requirements or of the means for meeting them. Indeed, it would seem that these requirements are none too fully comprehended even by inventors working along this line, if one may judge from the new designs frequently brought out, through the patent office or otherwise.

The principal makes of fuses now in use, while they cannot be considered as beyond the possibility of improvement, (a statement that would apply as well to other electrical devices) are nevertheless the result of years of development by the electrical manufacturers and have met the requirements of the National Board of Fire Underwriters as to their reliability. How well this confidence is justified may be judged from the extremely small number of cases in which complaints have arisen.

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TERMS OF SUBSCRIPTION.
THE ARMOUR ENGINEER, four issues, postage prepaid..$1.00 per annum

The first issue of the year 1914-1915 of THE ARMOUR ENGINEER is brought forth under the guidance of a new staff. The policy of THE ARMOUR ENGINEER, namely:—to publish high class articles written by graduates, instructors, or by men who have at some time or other been connected with the Institute, shall remain the same. The present staff shall endeavor to uphold this policy, and if possible increase the amount of material.

We realize that editorials from the pens of successful engineers are of great value to the student and to any one engaged in engineering practice. We shall strive to obtain these editorials for the benefit of our readers.

The following from the report of The Committee on Educational Courses submitted at the Fifth Annual Convention of The Electrical Vehicle Association is of interest as the proposal of a course in Electric Vehicle Practice first comes from men at the Institute. Dean Raymond has been instrumental in establishing this course in the Armour Institute of Technology Evening Classes where it is now being taught by Prof. Moreton.

"The 1912 Committee on the Establishment of Courses of Instruction in Electrical Vehicle Practise pointed out "The Need of Better Trained and More Dependable Men for Electric Vehicle Garage Work," and analyzed the educational field in which special training courses could advantageously be undertaken. The result of the Committee's work was the incorporation of a course in Electric Vehicle Practice in the program of the West Technical High School of Cleveland, Ohio.

"The same Committee for the year 1913 reported that the educational experiment in Cleveland was working out well and was giving renewed hope for the establishment of similar courses in other cities, particularly in those in which electric automobile factories are located. Some of the members of the Committee had visited the Cleveland Technical High School and assisted in the futherance of the undertaking, in which Prof. Short of that school had shown great interest.

"The influence of the activities of these Committees projected itself into the work of the Educational Committee of 1914, for the latter received an interesting statement from Dean H. M. Raymond of the Armour Institute of Technology of Chicago together with an outline of a course in electric vehicle practice which he proposed to include in the curriculum of that school.

"The Committee attaches sufficient value to the suggestion to reprint the synopsis of the course as proposed by Prof. Raymond, in the hope that it will stimulate educators in other institutions to become interested in the subject and to consider the carrying out of similar steps. In this work, the Sections of the Electric Vehicle Association can show themselves quite helpful to the objects of the Association by co-operating with the public school authorities in their respective cities, to the end that interest in the matter might be aroused and the subsequent

work of the Educational Committee be faciliated. This effort should not, however, be restricted to the technical high schools. In so far as it can be done, other educational institutions like public and private trade schools and Y. M. C. A.'s should be approached with the idea of securing their assistance along the same lines.

Course in Electric Vehicle Practice

As Proposed by H. M. Raymond and D. P. Morton.

(1) Development of the Electric Vehicle.
(2) Fundamental treatment of the direct-current circuit and electrical units.
(3) The direct-current generator and operation.
(4) Fundamental treatment of the alternating-current circuit, and alternating-current generators and motors.
(5) Theory of the direct-current motors.
(6) Construction of commercial types of direct-current motors.
(7) Operation and care of direct-current motors.
(8) Construction and operation of commercial types of motor controllers.
(9) The storage battery.
(10) Care of lead storage batteries.
(11) Care of Edison storage batteries.
(12) Charging stations and direct-current equipment.
(13) Motor generator sets and mercury arc rectifiers.
(14) Indicating instruments.
(15) Recording instruments.
(16) Electric wiring.
(17) The care of wheels, rims and tires.
(18) The chassis, its construction and upkeep.
(19) Hints about good driving.
(20) Comparative cost data, records, etc.

"Aside, however, from the strictly technical course of instruction above referred to, which aims to train electric vehicle engineers and competent operators, there is need of another course of less technical scope and bearing more directly on the training of electric vehicle salesmen. It should be the concern of the Educational Committee for the ensuing year to give practical shape to this suggestion. A synopsis would first have to be outlined, and when this has been approved, the text developed and finally worked out in detail. When the technical and the salesmen's course have been fully determined, it may become advis-

able to print the same in pamphlet form, enriched by appropriate illustrations, and give these pamphlets wide distribution to serve as a guide for educational institutions for day and evening instruction, and for central stations and manufacturing concerns for training courses among their employees.

"There is no question that if in all of the larger cities men could be obtained readily who have adequate knowledge of the design, construction, function and operation of electric trucks and vehicles, their quick availability would help to induce business people to buy such trucks and vehicles. Until, however, the demand for these specialists in the automobile field has made itself felt to a larger degree than is the case at present, schools will naturally be reluctant to add special courses to their curriculum appertaining to electric vehicle practice only; they might be far more ready to incorporate courses treating the whole subject of automobile design, construction and use, including in them proper references to the electric vehicle.

"It would seem, therefore, that simultaneously with, if not even preceding the efforts for co-operation with educational institutions, should be well-directed endeavor of the Educational Committee to induce central station managers and manufacturers of electric automobiles, automobile motors and storage batteries to train in their own places an adequate number of specialists in electric vehicle construction and operation. This should be accomplished so much the more easily as it could be shown to be to the direct financial interest of central stations and manufacturers to popularize the electric vehicle. The General Electric Company, the Westinghouse Electric and Manufacturing Company, the General Vehicle Company, among manufacturers, and the New York Edison Company and the Commonwealth Edison Company, among central power stations, are already maintaining educational courses, and in co-operation with them special courses for the purposes above mentioned could readily be worked out.

"All of this, of course, will require the close attention for some time of some one who has had practical experience in the field, the ability to develop the work along the desired lines and to write it up in clear and concise language, and the knack to secure co-operative effort from busy business men. He should

also build up a body of appropriate lantern slides and in connection with it develop a short lecture course which could be given in schools, Y. M. C. A.'s and similar assemblies, all for the purpose of creating a wider and more intelligent public interest in the electric vehicle. With such a man at hand, the Committee could place his services at the disposal of the various interests and thereby secure in a short time that which it might otherwise take a number of years to accomplish. If the carrying out of the proposed plan will gain to the Electric Vehicle Association and through it to its members the advantages herein stated and implied, the sooner the work is undertaken and the more forcefully it is pushed to its completion, the better it will be for all concerned.

* * * * *

"It must also be borne in mind that the electric vehicle at the present time plays only a relatively small part in the general automobile industry. Enthusiasm for and belief in its future possibilities and development must not unduly magnify the present needs of specially trained electric vehicle salesmen and operators, nor blind one's self to the fact that such enthusiasm and faith is not yet shared by the general automobile using public. It will, therefore, require persistent work and well directed effort to gain for the electric vehicle the place which it deserves in the automobile field."

* * * * *

The seventieth birthday of our Comptroller, Mr. Frederick Urling Smith, was celebrated on October 28th. As a token of their esteem the faculty and employees of the Institute presented Mr. Smith with a beautiful hall clock.

Mr. Smith retains that remarkable energy for which he has been known since the founding of Armour Institute of Technology. His interest in everything relating to the Institute has won for him the good will of the students as well as the faculty. We expect to see Mr. Smith in the Comptroller's chair for many years to come.

A New Department in the Institute

It may be of interest to alumni and former students to know that the Institute has assembled a number of the subjects which are commonly grouped under the heading of Mechanics and formed a Department of Mechanics. The work given in this department consists of the following:

Analytical Mechanics which extends through the entire Sophomore year and is taken by all second year students except the architects.

Mechanics of Engineering covers the subjects of Strength of Materials, Graphic Statics, Hydraulics and Hydraulic Motors and extends through the entire Junior year. This work is given to all third year students except those in the architectural and civil engineering courses. The architectural students receive instruction in Strength of Materials, but the Department of Civil Engineering retains all work formerly given to the students of that department except Analytical Mechanics.

The work of this new department is under the supervision of Professor C. E. Paul, formerly of the Department of Mechanical Engineering. Professor Paul is assisted by Mr. A. L. Ladd, a former instructor in the Department of Engineering Mechanics of the University of Michigan.

We are pleased to report that the following men have been recently appointed to our faculty:—

E. S. Campbell, assistant professor of architectural design, is a graduate of Massachusetts Institute of Technology,—B. S. 1906, M. S. 1907. He has served as assistant professor of architecture at the Carnegie Institute of Technology, and traveled abroad for two years in the study of his profession.

F. H. Childs succeeds Mr. Alling as lecturer on Business Law. Mr. Childs has been, at various times, instructor in law at the Kent College of Law, Chicago College of Law, Chicago Business Law School, and Walton School of Accountancy. He was lecturer on Business Law at Armour several years and at present is also a member of the faculty of the LaSalle Extension University. Mr. Childs is a member of the American Bar Association, the Illinois State Bar Association, and the Chicago Bar Association.

P. C. Huntley, instructor in experimental engineering, received his B. S. degree from Arkansas University in 1909. He was instructor at his Alma Mater from 1909 to 1913. Mr. Hantley has also been with the C., M. and St. P. Ry., the Harbor and Subway Commission of Chicago and with various engineering concerns.

W. C. Krathwohl succeeds Professor Dell as Assistant Professor of Mathematics. Dr. Krathwohl was recently professor of mathematics at Washington University and at Ripon College. From 1907 to 1911 he was instructor of mathematics at Barnard College of Columbia University. He received his A. B. degree from Harvard in 1907, M. A. from Columbia in 1910, and Ph. D. from Chicago in 1913.

A. L. Ladd assist Prof. Paul as instructor in the new Department of Mechanics. Mr. Ladd received his B. S. in C. E. and E. E. degrees from the University of Michigan in 1908. Prior to his appointment at Armour, he was instructor at the University of Michigan.

W. H. Lautz, Jr., instructor in architecture, is one of our graduates. He received his B. S. degree in 1913. Mr. Lautz has been connected with S. S. Bemam, Architect, since he graduated.

C. A. Nash, instructor in electricity, comes to us from the Agricultural and Mechanics College of Texas. Previous to this he was with the General Electric Company at Schenectady, N. Y., and for one year was instructor at the University of Maine. Mr. Nash received his B. S. degree in 1909 from the University of Illinois.

If you wish to become a successful engineer, follow the advice of Dr. Chas. H. Howe:—

"The successful engineering graduate will subscribe for the leading technical magazines in his line of work and he will not only subscribe for them—he will read them, in order that he may keep posted in regard to what men in his profession are doing, not only from the engineering standpoint but from the manufacturing standpoint as well. Too many technical graduates never take a technical journal.

"They say they do not need it for the work they are doing, which is probably true, and if they continue in that frame of mind the probability is they will never need to take the journals, because they will not rise to positions of high enough responsibility to make it necessary. The successful man—the man who is willing to do all that is in him to do—must know what other men are doing, and he must put his knowledge to use in the work which he does from day to day."

This applies to the student as well as to the graduate. Start along the proper channels *NOW*———by subscribing for THE ARMOUR ENGINEER.

"You have ideals, cherish them; you have ambitions, follow them; you have determined to make your mark in the world, make it. But when you do make that mark, in the name of all good records, make it so clear and so plain that other folks will know, beyond the peradventure of a doubt, exactly what it stands for." —E. F. Howard.

. . . . . "Let no student pursue an education alone for its material ends. He should strive to be not only a trained specialist, but also an educated man, and some day, if not now, he will see that the latter is as desirable as the former."

—I. O. Baker.

. . . . . "Thus it is that the commonest objects are by science rendered precious; and in like manner the engineer or the mechanic who plans and works with understanding of the natural laws that regulate the results of his operations, rises to the dignity of a Sage." —Rankine.

"Be strong, we are not here to play, to dream, to drift.
We have hard work to do and loads to lift.
Shun not the struggle, face it.
'Tis God's gift." * * * * *

—Maltie D. Babcock.

We often hear the complaint that the engineering profession is not recognized as it should be, as one of the foremost professions. The engineer completes his work, and, master though he may be, he is forgotten. The world looks on his achievements as ordinary events:—events necessary to make up life's routine. When he passes into worlds beyond, nothing but examples of his *work* remain; *he* is forgotten. But his work stands as a monument to his progress. What more could a truly great engineer wish for than to have his work stand and be remembered?

The following few lines by Edward Everett Hale in "The Unnamed Saints," convey our ideas of as fitting a memorial as could be given to any one. These words apply to many an "unnamed" engineer.

What was his name? I do not know his name.
I only knew he heard God's voice and came;
Brought all his loved across the sea,
To live and work for God and me,
Fell the ungracious oak,
With horrid toil
Dragged from the soil
The thrice-gnarled roots and stubborn rock;
With plenty filled the haggard-mountain side,
And when his work was done without memorial died.
No glaring trumpet sounded out his fame;
He lived, he died. I do not know his name.

No form of bronze and no memorial stones
Show me the place where lie his moldering bones.
Only a cheerful city stands,
Builded by his hardened hand;
Where every day,
The cheerful play
Of love and hope and courage comes;
These are his monuments and these alone—
There is no form of bronze and no memorial stone.

* * * * *

ARMOUR INSTITUTE OF TECHNOLOGY BRANCH OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

President .... F. L. Brewer, Jr.
Vice-President .... O. A. Anderson
Secretary .... J. A. Agee
Treasurer .... W. L. Juttermeyer

In accordance to custom the first meeting of the society was a smoker, held in the Armour Lunch Room on Thursday, October 8. Members of the faculty and the Senior class were out in goodly numbers, but the Juniors, to whom special invitations were extended were in a minority.

Mr. O. A. Anderson, acting chairman, introduced Mr. C. W. Naylor, chief engineer for Marshall Field & Company, who spoke on the advantages derived from active membership in an engineering society. The talk was exceedingly interesting and came from a worthy source, for Mr. Naylor attributes his success in the engineering world to his connection with engineering societies. Following Mr. Naylor, short talks were given by Profs. Gebhardt, Peebles, Libby, Anderson, Roesch and Mr. Bunge. Smokes were enjoyed during the meeting, after which refreshments were served.

The second meeting was held in the Engineering Rooms, Chapin Hall, on November 4. The speaker of the evening was Mr. L. D. Kiley, A. I. T. '12, now mechanical engineer for Chas. W. Hills, patent attorney, who gave a very interesting and instructive talk on "Patents and Patent Law." Mr. Kiley, being an Armour graduate was able to talk law in engineering terms, and thus disposed of his subject in a most interesting manner. This meeting was well attended, and the sociability was added to by the passing of several rounds of cigars and cigarettes.

Regarding future meetings, preliminary arrangements have been made with Chas. L. Rayfield and Charles Y. Knight of the Rayfield Carburator Co. and the Knight Motor Co. respectively.

—J. A. AGES.

ARMOUR INSTITUTE OF TECHNOLOGY BRANCH OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Chairman.............W. L. Borroughs
Secretary ....C. F. Wright
Treasurer ....J. F. Adamson

The Armour Institute of Technology Branch of the American Institute of Electrical Engineers was installed Feburary 26, 1904 by the national organization. The purpose of the branch is to give the student in electrical engineering an opportunity to hear and meet men who are prominent in the profession, and enable him to discuss or even prepare papers upon subjects of a technical or electrical nature.

The officers for the ensuing year were elected at the last meeting of the school year of 1913-1914 at the semi-annual banquet of the society, which was held at the Boston Oyster House. Several of the seniors gave excellent talks on their theses and interesting discussions upon technical subjects followed.

The first meeting held by the Society during the present school year was held on October 1. Prof. Snow opened the meeting by giving a talk upon some of the incidents of his trip as superintendent of a Chautauqua company last summer. Prof. Freeman then explained the purpose of the society and the benefits which might be derived by the student from the meetings and the opportunity of meeting men who stand foremost in their profession. After the meeting refreshments were served. The meeting was held in the Armour Lunch Room.

The second meeting of the Armour Branch was held on November 4 in the electrical lecture room. Mr. W. G. Martin gave an interesting talk on "The Scientific and Artistic Illumination of Interiors." The talk was accompanied by excellent stereoptican illustrations showing the possibilities of interior lighting. Mr. Martin, '12, is one of the many successful graduates of Armour.

—C. F. WRIGHT.

THE CIVIL ENGINEERING SOCIETY

President ....G. W. Sproesser
Vice-President ....G. J. Trinkaus
Treasurer ....L. D. Hook
Recording Secretary........E. R. Marx
Corresponding Secretary.....T. J. Kiene

The first meeting of the year was held in the engineering rooms on October 8. The speaker of the evening was E. F. Hiller, A. I. T. '06. He spoke on his work as efficiency engineer for the city of Chicago and told about the methods of examining applicants for civil service positions. The attention of the students was called to the opportunities offered to young engineers by the civil service commission. Mr. Hiller's talk was very interesting and thoroughly appreciated; for the members learned a great deal about what was before, more or less of a mystery to them. Professors Penn and Phillips were called on for a few words and responded with a continued discussion of civil service. Professor Phillips also told about the new Armour summer camp site. The words of the professors are always appreciated by the members. After the meeting a smoker was held in the Y. M. C. A. Rooms and a real social evening was enjoyed by all.

The second meeting was held on October 27. Professor Wells delivered a very interesting illustrated lecture on the construction of a car ferry dock at Kewaunee, Wisconsin.

The Armour Civil Engineering Society is really a live society. Meetings are held every two weeks and are well attended by members and alumni. Men prominent in the enginering world are procured as speakers to acquaint the students with the more practical problems of the profession. The A. C. E. S. is also a strong social organization. The smokers and annual banquets are always well attended and enjoyed.

Sophomores of the Civil Engineering Department are invited to attend the Civil Society's meetings as guests so as to become acquainted with the work of the society and be able to take up the responsibility of being members in their Junior year.

—E. R. MARX.

THE ARMOUR CHEMICAL ENGINEERING SOCIETY.

President .... R. D. Parrott
Vice-President .... G. B. Perlstein
Secretary .... C. Congdon
Treasurer............. A. N. Grossman

The first meeting of The Armour Chemical Engineering Society for the year 1914-1915 was held on September 25, at which the future policy of the society was discussed. After a warm discussion, it was decided that all speakers before the society should be our professors, alumni in chemical engineering work or professional men in their respective field of chemical work. rather than have the students engaged in chemical or any engineering work in the summer give their experiences. Great enthusiasm was shown by all members in an endeavor to make this year's work one of genuine social as well as educational benefit to all. After the collection of dues by our treasurer, the meeting was adjourned.

The second meeting was held on October 15, 1914, at which the first address before the society was made. Prof. McCormack spoke to us on "Reasons for the Non-Development of the American Chemical Industries." This is a matter of vital interest to those concerned with the chemical and allied industries, and has been a puzzle to those not acquainted with the conditions involved. Summarizing his address, Prof. McCormack gave his reasons for the lack of development by stating that the United States is as yet a young country compared to the European countries and that it had not as yet experienced the stress of living. American capitalists want quick returns on their investments, a thing hardly to be expected from industries requiring so much time and care in their development. Again, for this development there would be necessary a large staff of well trained technical men who would be willing to devote a large amount of their time to research work at a comparatively low salary. In Europe the small salary is compensated for by the respect and prestige given the men on account of the work which they are doing, and the fact that they for the most part hold positions as professors and instructors in many of the uni-

versities. This brings to light the fact that the Universities and the chemical industries are closely allied, a situation almost impossible to conceive in this country in as much as the average business man here does not hold the college professor in any high esteem. This country is not prepared to invest capital and labor in industries demanding such extensive care, intensive research, and wide development of allied industries, when the results are to produce such a variety of products, each on a comparatively small scale. After his talk, an informal discussion was held and interesting features brought out.

The next meeting of the society will be held on November 11, and an interesting talk is promised by our Prof. B. B. Freud on, "Modern Ideas in Organic Chemistry." We hope to have other interesting subjects presented during the course of the year and expect all members to be present at all meetings.

C. CONGDON.

FIRE PROTECTION ENGINEERING SOCIETY

President ....W. H. Rietz
Vice-President ....C. A. Grasse
Secretary ....E. M. Kratz
Treasurer ....L. Peterson

The Fire Protection Engineering Society held it first meeting of the year on Wednesday, October 7th. The meeting was called to order by last years' Vice-President. The election of officers for the ensuing year was the main business of the meeting.

The first of a series of lectures on subjects relating to Fire Protection Engineering was given on November 5th in the Engineering Rooms in Chapin Hall. This first lecture was given by Prof. Finnegan on "Insurance Inspection." His talk comprised some interesting points on the increased use of and improvements on wire glass windows and the hazards of shingle roofs. Another very interesting point brought out was the fact that every conflagration is indirectly caused by something going wrong, i. e., water supply, apparatus, etc. He then discussed the missionary work which a Fire Protection Engineer could do

in correcting small faults found in the home. There was a large attendance at the lecture with an audience made up of students from all departments, showing that not only the Fire Protects realize the practical nature of the subjects discussed.

The next lecture is scheduled for December 2nd and is to be given by Mr. Riddle of the Underwriter's Laboratories of Chicago. The aim of the society in having these lectures is to discuss the practical side of fire prevention and fire protection.

Students of all courses are invited to attend these lectures.

W. H. RIETZ.

THE ALUMNUS

THE MID-WINTER BANQUET.

The annual mid-winter meeting and banquet of the Alumni Association will be held in the Red Room of the Hotel La Salle, Saturday, December 19, 1914, at 6 p. m. The price will be $1.75 a plate.

In making the arrangements for this event no detail has been omitted by the Master of Ceremonies and the Board of Managers. Those who attend are assured an excellent dinner amid pleasant surroundings and an atmosphere of A. I. T. spirit and loyalty. A program of more than usual interest, including a large number of special features, has been arranged. For the sake of a surprise, we are withholding the name of a very prominent engineer who will make the principal address of the evening.

There will be everything that tends toward giving the guests a highly enjoyable evening's entertainment. Those who attend will miss you if you do not come, and conversely. So make a note of the date and place, and come.

AN IMPORTANT ANNOUNCEMENT.

At the last two or three meetings of the Board of Managers of the Alumni Association, tentative plans have been discussed for a monster reunion and celebration to be held by the Association in conjunction with the faculty of the Institute in the spring of 1917. At that time, twenty long years will have passed since the Armour Institute of Technology graduated its first class of engineers. It will therefore be a bi-decennial celebration for the Institute, the Alumni Association and the Class of 1897. The total number of Alumni will have grown to at least twelve hundred by that time, and this large body of technical men, all of whom owe their training to the good old A. I. T. should not fail to make this occasion a memorable one.

Many interesting features of the celebration are being planned by the committee in whose hands the matter has been placed by

the Board of Managers. Among these are class reunions for the Classes of 1897, 1902, 1907, and 1912 which will celebrate their twentieth, fifteenth, tenth and fifth anniversaries respectively; also a commemorative publication dealing with the progress of the Institute and of its human products, the Alumni. The whole matter will reach its climax at a monster celebration in Chicago to which every alumnus must plan to come. Remember the year—1917!!!

As the detailed plans become more developed, it may be found most appropriate to make the celebration commemorative of the twenty-fifth anniversary of the opening of the Institute, making the date fall in September, 1918. Early notification will be issued as soon as a decision has been reached.

THE SPRING MEETING OF 1914.

The success of the previous spring meeting and reunion, the first to be held at the Institute, was so manifest that similar arrangements were made for the last meeting held Saturday, May 23, 1914. Rivalled with the desire to again meet, shake hands and mingle with old classmates was a drawing card that consisted of nothing less than $40,000 worth of radium, with the result that the largest-ever gathering of Alumni was welcomed back to Alma Mater at this meeting.

The program began at 3 o'clock in the afternoon with an Alumni -Alumni baseball game, instead of the scheduled Alumni-Tech encounter. A pickup team from the different classes played another pickup team from the different classes. It did look like a Faculty-Alumni game, with "Doc" McMullen pitching for one side, and as customary we suppose his side won, though it didn't make much difference. It was all in fun—reunion.

During the course of the afternoon many found their way through the school buildings and all visited the new testing laboratory on Dearborn street, where a four-cylinder gas engine was on test. Guesses were made as to the horsepower being developed, Arthur Wagner, '03, proving to be the best calculator or guesser—we leave it to you how he did it.

The banquet was served in the gymnasium (all gatherings in the "gym" are not finals). There were 125 Alumni present, to

gether with a majority of the graduating class. We need not say the banquet was good—it is becoming legion that A. A. A. banquets always are—and this one was no exception. After cigars were lighted President Clausen made a few appropriate remarks and then introduced him we know so well, our friend, Dean Monin, who gave hearty welcome to all, spoke to each collectively, and gave of himself to all, adding more firmly to our regard for him. President Clausen called upon the president of the graduating class, C. C. Heritage, who represented one of the largest classes graduating from Armour Institute, and who voiced the willingness of his class to aid in Alumni Association affairs. Professor Phillips, in his best vein, made the boys good listeners to a few remarks appropriate to the occasion.

The cup donated by President Clausen and Vice-President Banning was presented to the class of 1899 in recognition of their having the largest percentage of paid-up resident members in the Association. The deBeers cup also was presented to the class of 1899 for having the largest percentage of attendance at the banquet. Following is the number of paid-up members and the attendance of the different classes at the banquet:

Class	Paid-up Members	Present
1897	10	0
1898	7	2
1899	14	7
1900	6	0
1901	8	2
1902	15	7
1903	18	1
1904	18	6
1905	23	8
1906	40	11
1907	55	8
1908	36	5
1909	47	12
1910	39	13
1911	52	9
1913	74	22

The business of the Association was then taken up, reports of the officers and committees being made. The treasurer, Fred G.

Heuchling, '07, reported the finances to be in better condition than the previous year, in spite of the fact that each paid-up member of the Association had received during the year a subscription to the Armour Engineer. This arrangement, rather a costly venture, has proved of benefit to the Association itself, its members and to the Engineer, and thanks are due the officers of the Association and the management of the Armour Engineer for the success of the arrangement.

Resolutions 1, 2 and 3, amendments to the constitution, were considered, put to vote and passed. These amendments as they affect the constitution are given on another page of this issue.

Election of officers, usually an uninteresting form of procedure, had considerable spirit injected into it, some of the offices being closely contested. Final returns were not all in until the evening was over. Results were as follows:

President	Fred G. Heuchling, '07
Vice-President	Fred R. Babcock, '03
Corresponding Secretary	Stanley Dean, '05
Recording Secretary	Paul Griffenhagen, '13
Treasurer	Tracy W. Simpson, '09
Master of Ceremonies	Thomas A. Banning, Jr., '07
Board of Managers to 1917	William B. Pavey, '99
	Henry W. Clausen, '94
	Fred T. Bangs, '13

Members of the Board of Managers elected at previous meetings are:

Board of Managers to 1916	Fritz A. Lindberg, '01
	E. O. Griffenhagen, '06
	F. M. de Beers, '05
Board of Managers to 1915	E. F. Hiller, '06
	J. B. Swift, '01
	H. A. Durr, '05

Through with elections, which occupied considerable time, the meeting adjourned to Science Hall, where was being kept that $40,000 worth of radium. Dr. Patrick O'Donnell told the history of the discovery of the new element, told of its wonder work, and illustrated his talk with interesting slides. The room being darkened, Mr. Pennington satisfied the curiosity of those present, showing the radium in plain sight, behind various

objects, still in sight, and added to the information given by Dr. O'Donnell. We don't doubt but what it was worth it—the radium $40,000, and the going to see it.

It was a very pleasant reunion, full up with smiles and handshakes with professors, with classmates and fellow alumni. Like those that have preceded it, it has helped bind our alumni in closer bonds of comradeship, and is one of the many that have made for a better one next time, added enthusiasm, and added loyalty to our Alma Mater.

AMENDMENTS TO THE CONSTITUTION AND BY-LAWS OF THE ALUMNI ASSOCIATION OF THE ARMOUR INSTITUTE OF TECHNOLOGY.

The following amendments were presented at the spring meeting of the Association, and were passed unanimously:

Resolution No. 1 provides for the establishment of a Booster Committee, composed of one active member of the Association from each graduating class. The purpose of the committee is, of course, to "boost," and each member assumes the obligation of boosting for his own class, to bring the proper influence to bear upon his classmates to interest themselves in the Association and attend its social functions. The committee will relieve the officers of the Association of a large amount of work, and will undoubtedly succeed in creating added enthusiasm by reason of personal appeal to their classmates. The resolution is designated as Section 4 of Article 9, and is as follows:

There shall be a standing committee to be known as the Booster Committee. This committee shall be composed of one active member of the Association in good standing, from each class of graduates, and each such member shall be the Booster Chairman for his class. The members of this committee shall be elected, and shall hold office as follows: At each regular spring meeting and annual election those members present from each class shall select one of the members of their class to be the member of the Booster Committee from their class during the ensuing year: the Vice-President shall fill any vacancies which may occur in such committee, and shall appoint members to the committee from those classes which may have failed to select their own class members at the annual election as above provided. The newly selected members of the Booster Committee shall assume office immediately after the regular spring meeting and

shall hold office until the following spring meeting, or until their successors are chosen. The members of the booster committee shall, if possible, be selected from among those members of their respective classes residing in Chicago or immediate vicinity. The Vice-President of the Association shall be ex-officio chairman of the Booster Committee; he shall preside over its meetings, and shall actively supervise its work. The class booster chairman from each class shall be directly responsible for the conduct of the Booster Committee work for his particular class, under the direction of the Vice-President. Each class booster chairman may appoint a sub-committee from among the members of his particular class, to assist him in the conduct of the booster work for his class, the number of members of each sub-committee being within the discretion of the corresponding class booster chairman. The life of each such sub-committee shall not extend beyond the next ensuing annual election.

Resolution No. 2 strikes out the first two sentences of Section 1 of Article X, and substitutes the part in italics:

It shall be the duty of the Board of Managers to appoint before the first day of May each year a Committee on Nominations. Such committee shall conssit of five members, one of whom shall be one of the retiring members of the Board of Managers having served three years, and the other four of whom shall be Active members of the Association in good standing not members of the Board of Managers; provided that no two members of the Committee on Nominations shall be chosen from the same class. This committe shall prepare and hand to the Corresponding Secretary in time to place on the notification of the annual meeting a list of nominations for the various offices to be filled. Nomination may be made by any active member present at the time of the election. Voting shall be by ballot. The presiding officer shall make appropriate provision for the conduct of the election and shall appoint three members of the Association as tellers, who shall count the votes promptly and report to the Recording Secretary.

Resolution No. 3 adds the last sentence to Section 3 of Article III, which now reads as follows:

The Vice-President in the absence or disability of the President, shall perform all duties ordinarily incumbent upon the President. The Vice-President shall be selected from among the members of the Booster Committee who have served as class booster chairmen during the closing fiscal year.

THE BOOSTER COMMITTEE.

This committee was inaugurated at the mid-winter meeting of 1913; selections then being made from the members of the different classes. Under the leadership of T. A. Banning, chair-

man of the committee, a great deal of benefit was derived to the Association, and to provide for the future existenc of such a committee resolutions were introduced and passed at the last spring meeting.

Members of the several classes were then selected to serve on the committee during the present yar. These class boosters are:

Chairman	F. R. Babcock, '03
1897	C. T. Malcomson
1898	E. H. Nagelstock
1899	A. H. Goodhue
1900	F. W. Zimmerman
1901	F. A. Lindberg
1902	W. H. Lang
1903	Arthur Wagner
1904	L. J. Byrne
1905	J. C. Penn
1906	
1907	J. T. Walbridge
1908	W. G. Wuehrmann
1909	H. W. Schlinz
1910	M. A. Smith
1911	G. B. James
1912	L. H. Roller
1913	E. R. Burley
1914	H. W. Perlstein

The committee meets frequently and plans and makes its campaigns for boosting attendance at banquets, the number of paid-up members in the Association, the membership of the scholarship fund; in fact everything that is worth boosting. These boosters aid greatly in the work of the Association and should be aided by all their classmates in their efforts.

ALUMNI ASSOCIATION SCHOLARSHIP LOAN FUND.

The committee in charge of the loan fund reports that its activities have steadily increased since the last statement, published in the Armour Engineer of November, 1913. The requests for aid are now so urgent that loans have been promised for several months in advance. It is earnestly requested that

all who are able to subscribe to the fund, either by becoming life members of the Alumni Association or by donations to the fund, will do so as soon as possible.

For the information of those unacquainted with the purpose of the fund above mentioned an article from the Armour Engineer is in part reprinted:

"The Alumni Association is extremely desirous of being a real benefit to the Institute and to the student body; in accordance with this desire an amendment was made to the association constitution in December, 1910, which provides for life membership in the Alumni Association upon payment of twenty dollars. In addition, donations to the fund may be accepted from any who desire to aid in the purpose of the loan fund.

"The fund so accuring is loaned to students in need of assistance, preferably upper classmen, so that they may complete their courses.

"The amounts loaned to any student are limited to $150, payable within two years after graduation, the loans bearing 5 per cent interest, the interest accruing being given over to the Alumni Association in lieu of the yearly dues of the subscribers to the Scholarship Fund. No security is required from borrowers, but an investigation is made into their needs, reliability and responsibility. This investigation is made by the Scholarship Loan Fund Committee of the Alumni Association working with the Deans of the Institute."

This committee includes one member connected with and at at Institute, and is as follows:

E. F. Hiller, Chairman, 4533 Ellis avenue.

Stuart Sainley Dean, Armour Institute of Technology.

F. A. Lindberg, care of Gardner & Lindberg, Marquette Bldg.

Applications for loans to one of the Committee members, or to the Deans, are invited, and will receive attention in so far as the available funds will allow.

Alumni of the Institute are requested to avail themselves of the privilege of becoming life members, thereby aiding others as well as themselves, and should communicate their intention of so doing, either to this committee or to the treasurer of the Alumni Association.

Comparative statistics of the fund as of October 21, 1914, and as of a year previous, are as follows:

	Oct. 1913.	Oct. 1914.	% Increase.
Number of life members........	29	44	52
Number of donations...........		1	
Total amount of funds..........	$580	930	60
Amount out in loans............	485	930	92
Total amount loaned...........	725	1570	116
Total amount repaid............	590	640	8
Balance available for loans......	95	0	
Total number of loans made.....	12	22	83
Total number of loans repaid....	6	8	33
Total number of students aided..	9	16	77
Range of loans, up to...........	125	150	20
Average amount of loan........	64	71	11
Average amount to each student.	81	98	21

A. I. T. Alumni Association Loan Fund
May 23, 1914

Life Membership by Classes

1897	0 1
1898	0
1899	0 1 2 3 4 5
1900	0 1
1901	0 1
1902	0 1 2
1903	0 1 2
1914	0 1 2 3 4 5
1905	0 1 2 3 4
1906	0 1 2 3 4 5 6 7 8 9 10 11 12 13
1907	0 1 2
1908	0
1909	0 1
1910	0
1911	0 1 2 3
1912	0
1913	0
1914	0

Life Membership by Courses

Civil Engineering.......	1 2 3 4 5 6 7 8 9 10 11 12
Mechanical Engineering..	1 2 3 4 5 6 7 8 9 10 11
Electrical Engineering...	1 2 3 4 5 6 7 8 9 10 11
Chemical Engineering...	1 2 3 4
Architecture	1 2
The Deans	1 2

The committee looks to the members of the Alumni Association to aid so far as possible in this undertaking.

E. F. HILLER, Chairman.

ALUMNI NOTES.

1897.

Gerald Mahoney is now located at Elkhart, Ind., where he is engaged in sales.

The following, clipped from the *Electrical Review and Western Electrician,* issue of September 5, 1914, will be of interest to all alumni: "Mr. Truman P. Gaylord, district manager of the Westinghouse Electric & Manufacturing Company at Chicago, has been elected acting vice-president to succeed Mr. Henry D. Shute, who becomes treasurer of the company. Mr. Gaylord was born at Shelby, Mich., and attended preparatory school at Allen Academy, Chicago. He subsequently attended the University of Michigan, and in 1895 received the degree of Electrical Engineer from the Armour Institute of Technology, Chicago. He was engineer of the underground construction during the World's Fair at Chicago in 1892 and 1893. At the close of the fair he became assistant professor of electrical engineering at the Armour Institute, which position he retained until 1898, when he became associated with the Commonwealth Electric Company, of Chicago, as electrical egineer. In July, 1899, he entered the employ of the Westinghouse Electric & Manufacturing Company as a salesman, following this line of work until 1902, at which time he was appointed district manager of the electric company at Chicago, which position he held until

the time of his election as acting vice-president. Mr. Gaylord is a member of the American Institute of Electrical Engineers, the National Electric Light Association, and a number of other engineering and scientific organizations."

1898.

E. E. Blodgett has gone into business for himself and is now an insurance broker with offices at 175 West Jackson Boulevard, Chicago.

1902.

L. A. Sanford, who has been with the Illinois Steel Co., is now in the engineering department of H. Koppero Co., Mallers Bldg., Chicago. This company seems rather partial toward Armour men, and have quite a number in their employ.

1903.

H. J. Hansen is in the engineering department of the Chicago, Milwaukee & St. Paul Railroad, Railway Exchange, Chicago.

W. W. Felt is with the Angert Wire & Iron Works, 6028 Grove avenue, Chicago.

1904.

E. L. Lundgren, who is in the Government Forest Service as District Engineer, is now stationed at Portland, Ore., in the Beck Bldg.

1905.

C. I. Jones is now engaged as dredging contractor at Racine, Wis.

H. E. Brashers, who has been with the Great Northern Railroad for some time past, is now assistant signal engineer for that company.

C. I. Holcomb is assistant engineer, Board of Supervising Engineers, Chicago Traction Co.

F. B. Whitney has left the Peoples Gas Co., Louisville, and is now consulting engineer with W. A. Baehr, 2009 Peoples Gas Bldg., Chicago.

F. M. de Beers addressed the members of the American Meat Packers' Association at their convention in Chicago, October 20, 1914. The subject of his address was "Saving the Squeal," and we leave it to you to imagine how he proposes doing it.

1906.

W. R. Wilson, formerly with the Studebaker Corporation, Detroit, Mich., has recently entered the employ of Dodge Bros., in that city.

Hans Schaedlich is now illuminating engineer, City of Chicago, 614 City Hall.

P. J. Scott is general manager, Bear Lodge Gold Mining Co., Sundance, Wyo.

M. B. Reynolds is holding one of the City of Chicago's best engineering positions. He is Engineer of Waterworks Design and is in charge of many important projects.

1907.

C. U. Smith has been promoted to maintenance engineer, Chicago, Milwaukee & St. Paul Railroad.

A. H. Boehmer is engineer in the construction department, Otis Elevator Co., 600 West Jackson boulevard, Chicago.

B. Hoffman, who has been in the manufacturing business in Milwaukee, is now associated with the Chicago Association of Commerce, Committee on Smoke Abatement and Electrification of Railway Terminals.

J. E. Saunders, formerly assistant signal engineer, Deleware, Lackawanna & Western Railroad, is now associated with the Union Switch & Signal Co., Swissvale, Pa.

1908.

H. W. Nichols, who has been teaching in the electrical department of Armour Institute of Technology the past four years, has accepted a position in the research department of the Western Electric Co., East Orange, N. J. The laboratories of this company at that city are among the best equipped in the world, and much of modern electrical engineering practice is evolved from them, and we are proud that one of our fellow alumni has been chosen to assist in the work of the institution. His address is 69 Carnegie avenue.

D. O. Barrett is now located in Mansfield, O., 78 South Main street.

W. I. Converse is chief engineer, Chicago, West Pullman & Southern Railroad. He lives at 119th and Morgan streets, West Pullman, Ill.

J. L. Hackett is inspector for the R. W. Hunt Co., engineers, Chicago. His address is 3762 Ellis avenue.

C. R. Morey, who has been water, light and sewer commissioner of Hastings, Neb., for a number of years, is now managing the North Platte Gas & Electric So., North Platte, Neb.

G. R. Wilsey is now structural engineer with the Graham-Burnham Co., 514 Columbian Bldg., Cleveland, O.

R. A. Winser, formerly engineer with the Missouri, Kansas & Texas Railroad, Dallas, Tex., is now chemist and engineer of tests, Chicago & Alton Railroad, Bloomington, Ill.

1909.

E. W. Chamberlain, formerly designer, The Concrete Steel Products Co., Chicago, is now working as engineer for O. J. Dean & Co., Chicago.

We have recently heard from Paul E. Chatain, who states he is doing some interesting work in the testing department of the Atchison, Topeka & Sante Fe Railroad, Topeka, Kan.

H. N. Ostergren, formerly associated with the Chicago Board of Underwriters, is now chief engineer and superintendent with L. K. Sherman & Co., engineers and contractors, Chicago.

Tracy W. Simpson, who should be known by all alumni, partly because he is treasurer of the Alumni Association, and mostly because he is a good fellow to become acquainted with, has resigned the superintendency of the Chicago factory of the Hotpoint Electric Heating Co. He is now in charge of the Specialty Sales Department of the Federal Electric Co., Chicago.

1910.

H. W. Martin is chemist with the International Harvester Co., Milwaukee, Wis. He recently announced his engagement to a young lady of that city.

A. J. Bergbom is draftsman for the Chicago, Milwaukee & St. Paul Railroad, Minneapolis, Minn.

J. M. Eckert has left the employ of the Indiana Steel Co., and is assistant engineer, gases and oils department, Underwriters Laboratories, Chicago.

T. G. von Gunten is now located at Great Falls, Mont.

R. S. ("Dutch") Kloman is now working in the Department of Streets, City of Chicago, 207 City Hall.

1911.

Raymond R. Zack is assistant to the City Engineer, Beloit, Wis., department of water supply.

G. B. James, who is with the Underwriters' Laboratories, Chicago, has obtained leave of absence, and at the present time is making a tour of the southwestern states studying the prevention of gas well fires due to lightning. The United States government has authorized the investigation and will issue a bulletin containing the data collected by Mr. James.

G. H. Emin has left the Chicago Telephone Co. to become western representative for the manufacturers of the Brunsviga multiplying machine.

J. G. Fenn, who has been factory inspector for the London Guarantee & Accident Co. in Chicago, is now supervising inspector for the same company in New York City.

J. H. Fletcher is electrical engineer for the Allen & Garcia Co., 934 McCormick Bldg., Chicago.

M. E. Gault is with the Holtzer-Cabot Electric Co., 6161 South State street.

H. W. Jones, who was city engineer, Oconomowoc, Wis., is now in the engineering department, Chicago, Milwaukee & St. Paul Railroad, Minneapolis, Minn.

It is with sincere regret that we report in these columns the death of one of the best men of the class of '11, John A. McCague, who was drowned while on his vacation in Michigan this summer. He was a friend to all, a credit to himself and his school, an exemplary Armour man in classroom, in social functions, and on the athletic field. His untimely death will be mourned by all who knew him.

A. H. Packer is with Roth Bros. & Co., manufacturers of dynamos, Adams and Loomis streets, Chicago.

H. N. Parsons has left Omaha and joined the large number of Armour men working for the City of Chicago.

C. J. da Silva is in railroad construction work at Pentwater, Mich.

1912.

R. B. Clark is with the Harding Conical Mill Co., New York City.

O. F. Abrahamson, who entered the engineering department of the Commonwealth-Edison Co. after his graduation, took the course given by that company at their Central Station Institute, and is now selling power and light for the local company at Bedford, Ind., and has met with good success despite the hard times.

F. A. Graham has left the employ of the Public Service Co. and is construction superintendent for the Kansas City Light & Power Co., Kansas City, Mo.

A. J. Beerbaum is in the engineering department, Western Electric Co., Hawthorne Works, Chicago.

Graham Armstrong, after working for the Commonwealth-Edison Co. the past two years, left for his home in Bloemfontein, So. Africa, during the summer. He was at Gibraltar when war was declared, but his boat was allowed to proceed to Cape Town and he reports arriving home safely, though we imagine he may be using some of his Armour-gained knowledge in warfare in his own country.

R. C. Armstrong severed his connections with the engineering department of the Western Electric Co. last spring and is now at his home in New Zealand.

E. L. Canman is with the R. J. Ross Manufacturing Co., Ogden and Kildare avenues, Chicago.

L. H. Roller is in the engineering department, Western Electric Co., Hawthorne Works.

1913.

B. H. Jarvis is working in the testing laboratories of the Peoples Gas Light & Coke Co., Chicago.

W. G. Stansel is at St. Louis, Mo., working in the signal department of the Chicago, Burlington & Quincy Railroad.

H. F. Israel was among those who traveled far from his Alma Mater to accept his first position after graduation. But he is back in Chicago again, and is working in the City Hall on corporation appraisals, at present that of the Public Service Co. of Northern Illinois.

F. T. Bangs is now in the division engineering department of the American Telephone & Telegraph Co., Bell Telephone Bldg., Chicago.

John Aeberly is department manager, Kellogg Switchboard & Supply Co., Chicago.

O. C. Badger is engineer in the road department, Chicago & West Towns Railroad, Oak Park, Ill.

Marston Curtis, after spending a year in Pittsfield, Mass., for the General Electric Co., is now in Lewiston, Mont., working in the engineering department of the Chicago, Milwaukee & St. Paul Railroad.

Walter Marx is with the American Wood Reduction Co., Chicago.

P. G. Pirrie is superintendent of production, Foulds Milling Co., Libertyville, Ill.

E. G. Westlund is doing civil engineering work for the City of Chicago.

John Wintercorn is working for the Aermotor Co., Twelfth and Campbell streets, Chicago.

1914.

P. F. Auer is with the American Coal & By-Products Co., Trasportation Bldg., Chicago. This company has just installed one of the largest coke ovens in the United States at Chattanooga, Tenn., and Mr. Auer assisted in the work of erection.

Carl Boetter is doing engineering work for the Chicago, Burlington & Quincy Railroad in Chicago.

C. A. Dean is in the drafting department of Hansell-Elcock Co., Chicago.

J. M. Emslie is with Armour & Co., Chicago, in the architectural department.

M. J. Fleming is county bridge inspector, Morocco County, Ind.

W. C. Gielow is an inspector with the Continental Insurance Co. of New York, 332 S. La Salle street, Chicago.

E. L. Hoffman is in the engineering department, Armour & Co., Chicago.

J. A. Holmboe is engaged in construction work at Grinnell, Ia.

J. A. Hallowed is working for the Great Lakes Dredge & Dock Co., Chicago, in the estimating department.

E. J. Hepp is an inspector for the Underwriters Bureau of the Middle and Central States.

H. E. Jedamske has been employed by Chicago, Milwaukee & St. Paul Railroad until recently.

E. C. Lang is in the electrical department, City of Chicago.

W. Oldenburger has taken Horace Greeley's advice and gone West. He is working for the Sierra Power Co. in California.

Joel Pomerene is in the construction department of the Chicago & Northwestern Railroad, Chicago.

M. I. Sevin is working as rodman in the bridge department, City of Chicago.

H. F. Smith may be extended all the congratulations due a benedict. He is selling concrete re-inforcing steel for Olney J. Dean & Co., 19 S. La Salle street, Chicago.

Stephen P. Walker hied himself back to his home town and is working for the Lytle Construction Co., Sioux Falls, Ia.

Meyer Willens is inspector of building construction, South Park Commission, Chicago.

Edgar Zack is associate editor of the Signal Engineer, Transportation Bldg., Chicago.

R. W. Whitmore is working in the engineering department of The Milwaukee Electric Railway & Light Co., Milwaukee, Wis.

Albert N. Koch is in the estimating department, Jos. T. Ryerson & Son, Chicago.

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(Signed) AL. N. GROSSMAN,
Business Manager.

Sworn to and subscribed before me this 5th day of November, 1914.

[Notary Seal] JULIA BEVERIDGE,
Notary Public.

My commission expires Jan. 8th, 1918.

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ELECTRIC RATES

BY G. E. MARSH*

Certain natural laws are present in the sale of any commodity and electrical energy is by no means an exception. It is unique, however, in its very nature and the circumstances affecting its successful production and utilization both from the physical and pecuniary ends are so completely original that the problems accompanying the establishment and success of the central-station industry require solutions peculiarly their own.

The sale of any article under different conditions, such as time, quantity, demand, etc., generally requires, and is accomplished by the aid of a certain number of rates, or a classification of rates. Examples are numerous and we may mention but several that easily come to mind: Freight rates depend on, among other things, the distance and kind of goods; steel and iron rates; gas rates, etc.

In the beginning the electrical industry adopted the method of the gas company and made use of what is known as a flat rate system. For the sale of gas this answers perfectly and under ordinary conditions permits of no improvement, not excepting of course, the demand of a consumer that the rates be lowered, as this is not a defect of the method and cannot be considered as such.

The rate system that is excellent for the gas company becomes very defective when used by a central-station. The problems are so very different that a much more complicated system has had to be devised to meet the situation. Various proposals have been made and tried out but the system that may be called a universal one is now unknown. Each system that makes for profitable operation of the electric company has its support-

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ers. Whether one system is superior to another is a difficult question to determine as no two stations operate under exactly the same conditions. In general, a successful rate system is the final result obtained by trying out and studying the effect of first one change and then another.

Very few are the companies that have worked out a system based directly on the fundamental factors involved in the case and disclosed by fine detailed electrical and commercial analysis of the problem as it presents itself.

There are rate-theorists and rate makers. The former have evolved systems for the determination of the proper rate under any set of conditions, but the complexity of them in general prevents any possibility of their application. A dozen or more years ago, the rate-makers were confronted with a very simple problem, viz., the total output of the station will be about so much and the expenses will be about so much; What is the proper charge to make per unit of energy? Stated in this manner, it sounds easy, and is easy, under some conditions. The rate-maker of the present time is expected to make a system of rates of the greatest equity compatible with the greatest success of the central station.

There are a number of terms that are used in the discussion of central-station operation, statistics and rate making that are not widely available and we will accordingly do well to give them some attention before continuing the study of rates and rate-making. They are as follows:

The symbols used in the mathematical expressions have the significance as shown:

p = instantaneous power demand,
p_m = maximum power demand,
t = time,
t_1 = beginning of a time interval,
t_2 = end of a time interval.

LOAD. Load is understood to mean the apparatus that is directly connected to the system and is receiving energy at the time considered.

CONNECTED LOAD. This is taken as the sum of the continuous ratings for continuous service of the apparatus connected to the system or a part of a system, as the case may be.

INDICATED PEAK. A peak load in kilowatts as given by an indicating or curve-drawing wattmeter.

INTEGRATED PEAK. The average peak load as obtained from readings of an energy meter divided by the time during which the peak existed This quality is clearly a function of the time limits of the peak and they therefore should be stated in order that comparisons may be made understandingly. In symbols, we have,

$$\text{I. P.} = \frac{\int_{t_1}^{t_2} p\,dt}{(t_2 - t_1)}$$

PEAK LOAD. This is the largest load carried by a station in any specified interval of time and for any specified period. The interval may be taken as a day, month, etc., and the duration of the peak may be taken as one-half hour or any greater or less time. If the peak load varies during this period, as is usually the case, then the average peak during this time is the value understood. Thus the peak load based on a five minute period might be very different from one based on a one hour period.

LOAD FACTOR. The load factor of a station, system or part of a system is the ratio of the average load to the maximum load during any specified interval of time. The average load is taken over a specified time, as a day, month or year, and the maximum load is taken as the average over a short period during the same interval. Thus the load factor may be given as the hour-yearly load factor, the five-minute-hourly load factor, etc. It is expressed mathematically as

$$\text{L. F.} = 100 \frac{\dfrac{\int_{t_1}^{t_2} p\,dt}{(t_2 - t_1)}}{\dfrac{\int_{t_1^{1}}^{t_1^{11}} p_m\,dt}{(t_1^{11} - t_1^{1})}}$$

Where $(t_1^{11} - t_1^{1})$ is understood to mean the shorter interval, such as hour, etc., and $(t_2 - t_1)$ stands for a longer period, such as the day, month or year. In many cases the year of 8,760 hours is the logical interval of time, especially in dealing with the system as a whole, as for use in connection with statistics from which guidance in preparing for future growth is obtained.

THE DAILY LOAD FACTOR. This is the ratio of the average load for a day (twenty-four hours) to the peak load of that same interval.

In symbols

$$\text{D. L. F.} = 100 \frac{\dfrac{\int_{t_1}^{t_2} p\,dt}{(t_2 - t_1) = 24 \text{ hours}}}{p_{max}}$$

THE YEARLY LOAD FACTOR. This differs from the preceeding only in the interval of time. It is the ratio of the average load for a year to the peak load of that same time.

MAXIMUM DEMAND LOAD FACTOR. This is defined as the ratio, expressed as a per cent of the energy, or kilovoltamperes, delivered by a station, system or part of a system, in a specified interval of time, as a day, week or month, to the energy, or kilovoltamperes, which would have been delivered in the same time if the output had been constant at the maximum rate attained during the specified time.

In symbols, we have,

$$\text{M. D. L. F.} = 100 \frac{\int_{t_1}^{t_2} p\,dt}{p_{max}\ (t_2 - t_1)}$$

PLANT FACTOR. This is defined as the ratio of the average load to the rated capacity of the station or system.

$$\text{P. F.} = 100 \frac{p_r \int_{t_1}^{t_2} p\,dt}{(t_2 - t_1)}$$

CAPACITY FACTOR. The ratio of the greatest average load for a specified period to the maximum capacity of the station, system, or part of a system for this same period. If the maximum one-hour load on a station were 3,600 kw and its maximum capacity for a one hour period were 4,000 kw, the capacity factor would be .9 or 90 per cent. The period may be taken as any convenient interval of time as the case may require but as the capacity factor will depend on this period, its statement must be included in each case. If the capacity factor be 100 per cent when one day is taken as the period, the system is evidently fully loaded. If, however the period were one hour, or less, say, and the capacity factor had the value 100 per cent, then the continuous full-load limit of the station has been exceeded, as the rating of a plant on a one hour basis is greater than on a three, six or twenty-four hour basis.

The difference between the capacity factor expressed as a per cent and 100 per cent is the capacity that is available for future growth, or may be reserved for emergency demands, etc. Mathematically, the capacity factor is represented by

$$\text{C. F.} = \frac{\left(\dfrac{\int_{t_1}^{t_2} p\,dt}{(t_2 - t_1)} \right)_{max}}{p_{max} \quad t_2 - t_1}$$

DIVERSITY FACTOR. The diversity factor is defined as the ratio, expressed in per cent, of the sum of the average simultaneous demands of a number of individual receivers, services, or customers, for a specified period, such as an hour, and the sum of the maximum demands of the individual receivers in the same time the demand in each case being measured at the point of

supply. This is the definition adopted by the National Electric Light Association and it is given in symbols by the expression

$$\text{D. F.} = 100 \frac{\displaystyle\sum_{1}^{n} \frac{\int_{t_1}^{t_2} p\, dt}{(t_2 - t_1)}}{\displaystyle\sum_{1}^{n} p_{max}}$$

The International Electrotechnical Commission has defined the diversity factor as a number obtained by dividing the sum of the maximum loads of the individual consumers during a given period by the maximum load carried by the station during the same period. This agrees with the definition given this quantity by the American Institute of Electrical Engineers. Symbolically it is

$$\text{D. F.} = \frac{\sum p_m}{P_m}$$

The diversity factor has also been defined otherwise and it is therefore necessary, at the present time, to know what definition is understood or referred to when the term is used in the literature. The several values of 2., 0.5, or 50 per cent may be given it, according to which of the definitions has been adopted.

THE CONNECTED LOAD FACTOR. This quantity is defined as the ratio of the energy or kilovoltamperes, consumed in any given time by a load to the energy, or kilovoltamperes, which would have been consumed by the same load in the same time, if the load had constantly consumed energy, or kilovoltamperes up to its full rated capacity. We may speak of the connected load factor of an entire system, a single customer or of a single piece of apparatus.

In symbols, we have,

$$\text{C. L. F.} = 100 \frac{\int_{t_1}^{t_2} p\, dt}{p_r\, (t_2 - t_1)}$$

CAPACITY LOAD FACTOR. This is the ratio, expressed as a per cent, of the energy, of kilovoltamperes, as the case may require, delivered by a station, system, or part of a system during any specified interval of time, as a day, week, or month to the energy, or kilovoltamperes, which would have been delivered if the output had been constant and at the rated capacity for the same period. In symbols

$$\text{C. L. F.} = 100 \frac{\int_{t_1}^{t_2} p\,dt}{p_r\,(t_2 - t_1)}$$

DEMAND. The demand is a load that is specified, contracted for, or connected to the system for a specified time and is expressed in kilowatts, kilovoltamperes, amperes, or other units. The load referred to is that at the receiving end of a line, feeder, etc., and the actual load on the plant is of course greater than this by the loss in transmission.

SIMULTANEOUS DEMAND. The simultaneous demand is the sum of the individual demands co-existing on the system or a part of the system, for a given time. The simultaneous demand is never greater than the sum of the individual demands, as is clearly seen.

MAXIMUM DEMAND. The largest average demand in kilowatts for any specified time as an hour, quarter-hour, etc. This is obtained by measuring the energy delivered in the time specified and dividing it by this time.

MAXIMUM INDICATED DEMAND. The largest instantaneous demand in a specified time and is obtained from an indicating or curve-drawing wattmeter.

MAXIMUM SIMULTANEOUS DEMAND. The greatest demand at any time resulting from a number of individual demands on the same system or part of a system. The maximum simultaneous demand equals the sum of the individual demands only when they all occur at the same time.

DEMAND FACTOR. The demand factor is the ratio of the maximum demand on any station, system, or part of a system, to the total connected load of the station, system, or part of the system, as the case under consideration may involve.

EFFECTIVE DEMAND. The effective demand of a single load, feeder, or part of a system, is the demand of the latter at the time of maximum demand on the system.

FLAT RATE. This is the term applied to a method of charging a central station customer that is based on the size and character of the receiving equipment and not at all on the time, duration or magnitude of the power demand. The monthly charge is independent of the energy consumed.

METER RATE. Meter Rate is a method of charging for central station energy that is based on the energy consumed and measured by an energy meter. The charge may be constant for any amount of energy consumed or it may vary with the total registration, or with the component parts of the total when the latter is partitioned according to any specified plan.

STEPPED METER RATE. This is one in which a specified price per unit is charged for all or any part of a specified amount of energy consumed and with successive reductions in the price per unit based upon specified increases in the amount of energy consumed in a stated time. The charge is therefore the sum of the products obtained by multiplying the several amounts of energy consumed by the corresponding price per unit.

To illustrate this we may take the following case. In the case of a customer using energy billed him according to the plan; 12 cents per kwh for the first 30 units, 8 cents for the second 30 units, and 4 cents for all other units, his bill for 100 kwhs would be

$$(30 \times .12) + (30 \times .08) + (40 \times .04) = \$7.60$$

TWO-CHARGE RATE. This is the term applied to a method of charging a central station customer that is based on the energy consumed and on the full-load rating or demand of the installation. Dr. John Hopkinson established the sound principle involved in the two-charge rate in 1892 and it is frequently spoken of as the Hopkinson or Manchester Rate.

DEMAND RATE, or MAXIMUM DEMAND RATE. This is the term applied to a method of charging a consumer of electrical energy that is based on his maximum demand in a specified time, as a month. To determine and record the magnitude of this maximum demand some form of maximum-demand indi-

cator is used. This is a device that measures the maximum current (and power, indirectly, at constant voltage) and is known as a "maximum demand meter." The record is not that of a peak load continuing for a few seconds only, as is produced, for example, by the starting of motors, but that which existed for several minutes in the case of large installations and for fifteen or more minutes in the case of small ones.

This rate system is commonly known as the Wright or Brighton Demand system as it was devised and first used in Brighton, England, by Mr. Arthur Wright.

To illustrate the demand rate we may take the following example. The demand charge is made on a number of hours per day, generally one, thruout the month, or other interval for which the bill is rendered, at the maximum demand rate, and the remainder of the total energy consumed at a lower rate. If the high, or maximum demand, rate be 10 cents and the low rate 6 cents per kilowatt hour, then an a 110 volt system if the maximum demand meter registered 9.1 amperes, the power demand would have been $9.1 \times 110/1000 = 1$ kw approximately. On this basis, the energy to be charged at the high rate would be 30 kwhs. If the watthour-meter showed a total consumption of 50 kwhs, then the bill would call for the payment of \$4.20, calculated thus: $(30 \times .10) + (20 \times .06) = \$4.20$.

THE THREE CHARGE RATE. Also known as the Doherty Rate and dates from 1900. This is a method of charging a customer that is jointly based on the electric energy consumed, on the full-load rating or demand of the installation and a fixed charge per consumer.

"Readiness to serve" is a term employed in rate making and refers to the charge made in certain systems to cover the costs of company operation that are independent of output, in fact, to meet such expenses as arise from the system being in a condition ready to serve on instant demand. The Doherty Rate System is often called the Readiness-to-Serve System.

CONSUMER'S OUTPUT RATE. The term Consumer's output Rate is given to a method of charging for energy that is based on the output of the receiver. This applies to an ice-plant, a pumping station, etc.

STRAIGHT LINE RATE. This is the term applied when

the total charge is the product of the charge per unit and number of units used. T (total charge) $=$ a (charge per unit) $\times$ n (number of units).

BLOCK RATE. The term block is used when there is a specified price per unit of all or any part of a block (quantity) of energy, and different prices are specified for any or all of the succeeding blocks of the same or different sizes, each price per unit applying only to a particular block or a portion thereof. The total charge is the sum of the products obtained by multiplying the number of units in each block by the corresponding price.

Some rate theorists have made the statement that the charge made any customer must not be more than he would be required to pay if he obtained equally good and similar service from another source. Usually the customer has no choice in the matter of selecting his central-station for any one of several self-evident reasons, such as lack of competing electric companies, by virtue of his residing in a district served by but one company, etc. Accordingly, such a basis for rates is, at the best, a poor one and further analysis shows that is possesses serious defects.

In the unusual case of a customer residing in a district equally well served by two companies, it is clear that real competition places an upper limit to the permissible charge that may be made per unit of energy sold, but not otherwise. The lower limit is always fixed by the cost of production.

Energy manufactured at a constant rate and stored until used is necessarily much cheaper than it is when manufactured and delivered on demand. This difference between manufacturing energy at leisure, and on particularized or specialized demand, is what gives rise to the entire subject of electric rates. The production of artificial gas is an example of energy in a cheap form. Were this gas required to be made on demand just as electric energy is, its cost, and therefore its price, would be tremendously increased.. Consider for a moment the problem of a gas company whose plant had no storage capacity and trying to operate under ordinary conditions of demand.

The entire cost of production may be divided into two parts, one being fixed and substantially constant regardless of output and the other variable and proportional to output. The proper

and equitable distribution of these factors among the consumers of the energy is the real problem of the rate maker. Thus it is that a system of rates based only on the amount of energy used is evidently unfair to the central station and to the consumers as well, as it would prevent an equitable distribution of the fixed expenses among the various consumers. The short time consumer would have to be charged at a much higher rate than the long time consumer if he were to contribute his part of the fixed expenses.

Under the ordinary system of charging, a consumer who is provided with two means of energy supply, especially for lighting, will generally use electricity for short time requirements and gas or oil for long-time consumption.

The process of delivering energy, of maintaining pressure on a consumer's premises is known by the name of service. The cost of service is made up of such elements as taxes, depreciation, interest on investment, maintenance, etc., that pertain to conduits, feeders, mains, lines, meters, etc., and the cost of reading meters, billing, etc.

Taking a large number of central stations as a whole, it was found that the cost of service, the cost of delivering energy to the consumer, was never less than the cost of production, and in some cases, it was nine times as large. In general, we may say that from 50 to 90 per cent of the total charge is for service and is therefore a fixed component, and is not affected by any improvement in the efficiency of the generating equipment or in the apparatus constituting the load. Incidentally, it may be remarked that from a careful examination of 20 central stations in cities ranging from 4,000 to 600,000 inhabitants it was found that the stations showing the best earnings on total investment were those making the least profit per kilowatt-hour. These same stations also had the largest plant factors.

Even though a consumer may have used no energy during a given billing period, usually a month, the central station has given continuous service in maintaining electrical pressure on the consumer's premises. There has been constantly available for the instant demands of the consumer what amounts to a certain portion of the generating and transmitting capacity of the system. The act of securing a service connection is virtually that

of renting for constant or intermittent use, a certain fraction of the system, and hence he rightly assumes a certain charge for service that is independent of any energy consumption.

The cost of electric energy at the place of production, and not delivered at a distant point either in constant or varying quantities, is dependent on a great many factors such as cost of coal, water, land, labor, taxes, efficiency of generating equipment, etc. The upper and lower limits of the cost of production in plants of moderate size under average conditions are fairly constant. Accordingly, if the cost of service be not considered, the cost of delivered energy is substantially the same under all ordinary conditions. The expenses that are directly or indirectly incurred in the actual production of electrical energy make up the cost of the same. Those that arise, directly or indirectly, from the need of the central station to be constantly in a position to supply energy on instant demand, constitute the cost of service.

It has been stated that the investment and maintenance cost for meters alone for large groups of central station consumers is greater than the investment and maintenance costs of the generating equipment supplying those consumers and it is possibly true. It is, at least, startling, and shows the relative magnitude that some of the elements of the cost of service assume.

In the ordinary case of charging for energy no distinction is made between the energy charge and the service charge, the two being expressed as a kilowatt-hour, or energy, charge, and at such a rate as is required for a satisfactory return on the investment. Bearing this in mind, it will be clear that every time the receiving or consuming apparatus, whether it be a lamp or other device, is improved in efficiency, the energy charge component is reduced, and the service charge component is increased, if the station income is to remain constant.

We are interested in examining the problem of electric rates themselves as well as the shape or form in which they are applied. It must be borne in mind that the manner in which they are calculated, devised or formulated is one thing and the form they take on in the application is something else. As an example, let us suppose that each of three stations of about the same size and operating under the same general conditions, supplies

a small drygoods store. These stores are of the same general character and provide the same kind of load both in size and period of maximum demand. One has a straight meter rate of 6 cents per kw. hr. and pays for his 250 kw. hrs. $15 a month. The second has a Hopkinson or readiness-to-serve rate, pays $5 per kilowatt of demand capacity plus 4 cents per kilowatt hour, making also $15 per month for his 250 kilowatt hours. The third has a flat rate of $15 a month. Now, in these three cases, and others might be added, the manner of charging is very different but the rates are really the same, since the same amount of energy brings in the same amount of revenue for each of the three stations. If, however, the second station had a flat rate, as well as the third, and the merchant paid but $10 for his 250 kilowatt hours, then his rate is evidently different from that of the other two.

In general, if it is found that any particular class of consumer pays the same per unit of energy whether in one city or another, then the real rate systems in force are the same in those two cities.

Consider the case of a central station having only a lighting load of 3.1 watts per mean-horizontal-candle power, 16 c. p. carbon lamps. The energy consumed in each lamp would cost the patron, in 1,000 hours, at 12 cents per kilowatt-hour, six dollars. Had the 20 c. p., 2.5 watts-per-mean-horizontal-candle power, (w. p. m. h. c. p.), gem lamp been used, the energy cost would have also been six dollars, but the patron would have had about 25% more light. Suppose, further, that using the carbon lamps the income to the station was $25,000 a year and the net profit was $2,500 the expenses were therefore $22,500.

If this were the situation when the 1.25 w. p. m. h. c. p. tungsten lamp appeared, and the latter were substituted for the carbon lamp, we find that with the same consumption we would have 2.5 times as much light as before, or the same amount of light, with but 40 per cent as large an energy consumption. The energy cost would be, for equal quantities of light, $2.50 and the income of the station would be only $10,400; in place of previous profit there is now a deficit of $12,100. In practice such a condition did not, or was not allowed to happen, by virtue of causes that we have not the space to discuss here. However, this kind of calcula-

tion when made six or eight years ago, was far from making the officers of the central station certain as to their future prosperity.

Let us now separate the cost of service into two parts as follows: The first part to be proportional to the maximum demands of the consumers—this includes by far the greater part of the fixed charges, a portion of the operating expenses of the station and a portion of the investment and operating expense of the distribution system. This may be called the Demand Service component of the Service Charge. The Demand Service Charge per kilowatt of installation equipment should vary with the size of the installation and in order that the method would be applicable to a small lighting consumer as well as to one having large power requirements, is evidently inversely proportional to the size of the installation.

The Personal Service Charge, the second part of the total Service Charge, includes portions of the fixed and operating expenses, mainly those of distribution, that vary with the number of consumers on the system. Among the components of this part are maintenance of the distribution system, meter expense of various kinds, service connections, billing, inspection, clerical work, etc. These items are practically constant and not dependent on the amount of energy consumed. They vary somewhat with the maximum demand and to a small degree with the density of service connections.

If in any case an examination of the revenues derived from individual consumers shows that the sum of charges made any two separate installations operating with similar and equal conditions of maximum demand and total energy consumptions is less than the charge made a third consumer having twice the maximum demand and twice the energy consumption, then the rate system in use is defective and the element of Personal Service Charge has not been properly calculated or applied. The charges are not equitable and the continuance of the system works as a hinderance to the natural growth and prosperity of the central station.

The charge made the large consumer is mainly for energy and for service in the case of the short time user. This similiarity demands that full consideration be given the data of companies having a large preponderance of short time users when the analy-

sis is made preparatory to the establishment of the logical and correct method of charging the patrons of the system. It is, therefore, a proof of the successful working of a logical rate system when, in the above example, the income derived from the two consumers is greater than that derived from the third.

One important principle that is disclosed by a detailed study of the factors underlying a logical rate system is that the average cost obtained by considering a number of consumers of the same kind and then used in the calculation of the rate system is not theoretically correct. Users of energy coming within the same ordinary class-limits, that is, of maximum demand and total energy consumption, differ among themselves, in the matter of location, time of maximum demand, etc., so that the average obtained in the usual way is larger than the true amount some should pay and smaller than others should pay. An example will make this clear. A and B are two patrons of the same station, have similar and equal energy requirements and pay the same total charge. A lives close to the station and B in a suburb. They pay the same because the rate was obtained by averaging service costs, but by reason of smaller investment and maintenance cost of distribution that A involves, over that of B, the former should have a smaller total charge.

Let us carry this analysis, the separation of the total cost of energy into real factors, further. Some of these factors are easy to recognize, others, not so easy. A rate system founded on these real factors, of which we can easily discern ten, they being the most prominent ones, will take them into account and proportion the resulting charges to the consumer in amounts that are actually proportional to the expenses caused by him individually.

First: A Fixed Charge to cover all those expenses that are directly proportional to the number of consumer such as portions of the investment, fixed charges, and nearly all of such items as billing, clerical costs, administration, etc.

Second: An Energy Charge determined by the cost of energy.

Third: A Load Factor Charge—determined by the average load factor of the consumer.

Fourth: A Demand Factor Charge—determined by the maximum demand of the consumer and the time it occurs.

Fifth: A Distance Charge—determined by the distance factor in the initial and maintaining costs of the line supplying energy.

Sixth: A Right of Way Charge—determined by the initial and maintaining costs of the kind of line used, whether overhead, on its own poles, or on those shared with other users, etc., whether the line is underground in conduit of one kind or another, and in a dirt alley or an asphalt covered street, etc.

Seventh: A Regulation Charge—determined by the requirement on the steadiness of the supply voltage.

Eighth: A Quality Charge—determined by the power factor of the load, power loads being distinguished from lighting loads.

Ninth: A Change Charge—determined by the customer, whether a house-owner, a long-term consumer, or a tenant in a low priced flat building, where the people move frequently and therefore necessitate frequent changes in records, meters and increased attention, etc.

Tenth: A Distribution Charge—determined by the nature of the supply, whether it is required as a single quantity or as several smaller quantities delivered at several points and therefore requiring a larger investment and loss in distribution.

We may now examine at more or less length the several rate systems that are commonly used and by numerical examples obtain a better understanding of them.

Flat rates are not suited to all classes of consumers, as the long-time consumer pays less than cost, and the short-time would have to pay more for energy than he would if he used other means. If the consumer had a large rated capacity but a small maximum demand, the cost by this method of charging would be excessive. Frequent inspection is necessary to prevent fraudulent use of energy by increasing the number of outlets, using lamps of higher wattage, etc. Further, the consumer tends to curtail his equipment.

On the other hand, if the flat rate is high enough, the station is assured of satisfactory income that can only be reduced thru fraud on the part of the user. The clerical system is simple; there is no meter or meter-reading expense, and the rendering of bills becomes a very simple matter, and under certain circumstances it is easy to imagine how even this procedure could be dispensed with.

This system of rates can be used with a current-limiting device which can be set so that the load for which the consumer is to be charged cannot be exceeded. If the house wiring is done by the company furnishing the energy, this system of rates makes for a low cost of installation and when the consumer has need of but a few lights and these, perhaps but for a short time each day, the flat rate is the only one that will add this class of customers to the central station. In order that there may be a return on the investment in such cases it is imperative that the costs of installation and service shall be a minimum.

A meter rate that is based only on quantity of energy consumed has the disadvantage that it does not discriminate between customers of unequal value to the station. The charge is the same regardless of load-factor, or time of maximum demand of the user. A smaller amount of energy sometimes costs more than a larger amount.

Uniform meter rates, like flat rates, are not equally fair to all consumers as the short-time user does not pay his proportional part of the fixed expenses and the long-time user pays more than his proportional part and more than he could get service for from another source. It is this class of user, the one with high load factor, that is the most profitable to a central station using this system of rates. Conversely, it is this system of rates that is the greatest encouragement for the installation of isolated plants as energy can be produced by them cheaper than can be bought under a uniform rate system.

This system works for an increase in the maximum demands to the detriment of the load factor. The only advantage worth considering, that this method of charging possesses, is that the actual cost of metering, billing, etc., is exceeded by all other systems save the flat rate system.

In the case of meter rates with a minimum charge, it may be said that the minimum charge does not, in general, represent the minimum cost to station for "readiness-to-serve," and that this system, like the preceding ones, does not offer any inducement to the more desirable class of patrons. On the other hand, the minimum charge partially or wholly insures the company against very poor load-factors necessarily resulting from short-time consumers. It is thus possible for the company to have such a min-

imum charge that no consumer is carried at a loss, as is the case of some other methods of charging, and with the result that the more profitable consumers may be given a more attractive and equitable rate.

The New York system is one where the consumer pays a high rate for the first one, two or three hours use of his total capacity, all additional energy being given him at a much lower rate. This is a method based on the time the maximum capacity of installation is used. Regarding it, we may say that it is not suited to all classes of customers as the short-time user pays less than the cost of service and it discriminates against the user having a large equipment but small demand.

The consumer with high load factor pays the same rate for a given time that the short-time consumer does, and yet the former is the much more valuable to the company. This system, like others already discussed, tend to encourage fraud and restrain natural growth of the installation.

It may be said in its favor that it encourages improvement in load factor of the consumers already having a high load factor, that it is in practice and installation more simple than a two-rate system, or the Wright demand system. The fundamental reason for the New York or Wright demand system is the idea that the larger the consumption the less is the cost of service. It is a mistake to think that under all conditions the larger the consumption of energy, the less is the cost of production.

The Wright Demand System is the method of charging based on the total time maximum demand is used. Under this system the short-time consumer may not, and generally does not, pay the full costs of service, and hence the long-time consumer pays more than his proportional share to compensate for the losses due to the former class of patron. Since, for a given consumer, small cost goes hand in hand with small maximum demand, the system works to the reduction of both consumption and installation. The charge is not closely related to cost, though it more nearly approaches the latter than is the case in any of the preceding systems. This is a complicated two-rate system, is not generally understood by the consumer, and therefore does not serve to give the patron confidence in the company.

System using the General Electric Company's two-rate meter: A system of rates that vary with the time of day energy is used. The meter records energy used at times when the station load is heaviest and such amounts accordingly pay a high rate. Other energy is charged at a low rate. This system has serious theoretical and practical shortcomings. It charges most for energy that is cheapest to generate. Though it encourages consumption at some desirable hours, it does not favor the long-time consumer over the short-time patron, and the latter does not pay enough for the service. It discourages the use of light at a time when it is needed. The meter is expensive, requires frequent setting and supervision.

"Readiness to serve" calls for a certain expense and an increase in the consumption does not produce a corresponding increase in the expense. These expenses, on the basis of "readiness to serve," are determined by the number of customers and the maximum demand of each one. The charge for readiness to serve is to be fixed by the minimum cost of all fixed charges and fixed expenses of the station. This system charges the consumer his proportional part of the actual station cost for readiness to serve, and allows him to contract for whatever capacity he chooses, but would prevent a greater demand by any suitable means such as a fuse, circuit-breaker, etc.

Under the Doherty system of charging it is claimed that there is a greater uniformity of rates, that there is a tendency to produce a better station load factor and that unprofitable business is eliminated. These and others are clearly possible under a proper application of the principles involved.

The charge for readiness to serve is based or proportioned among three factors, (a) customer, (b) meters, (c) maximum demand.

Let us now consider the application of this rate system to an actual case. The central station served 900 customers having 925 meters and 18,000 lamps. During the preceding year the gross income was $38,480.18, derived from the sale of 307,389 kilowatt-hours at an average price of $0.12518. The fixed expenses comprised by taxes, interest, insurance, depreciation, salaries, administration, repairs, etc., amounted to $8.908, or $9.898 per consumer. The expenses proportional and chargeable to

meters installed was \$2,796.00, or \$3.022 per meter. The expenses chargeable to kilowatt-hour output were \$16,133 and this distributed among all the lamps gave \$0.896 per lamp. The expense per lamp demand, assuming the maximum load was two-thirds of all lamps on the system, was \$1.344.

The three components of the readiness-to-serve charge are

\$ 8,908.44	chargeable to consumer.
2,796.00	chargeable to meter.
16,133.32	chargeable to capacity.
\$27,837.76	

The total expenses are greater than this total by the costs incident to the actual production of energy and by reason of such items as fuel, labor, profit, etc. This component was \$10,642.42, making the total year's expense \$38,480.18. Of this amount we have already accounted for \$27,837.76 and the difference, \$10,642.42, is the amount that is to be derived directly from the sale of energy. As the output was 307,389 kilowatt-hours, the proper energy rate is therefore \$0.03475.

Accordingly the individual consumer will have fixed charges as follows:

\$ 9.898	chargeable as consumer expense.
3.022	chargeable as meter expense.
17.900	(12.33×1.344, for an installation of 20 lamps, the average.)
\$30.820	

and this independently of any energy charge. Assuming that he uses 17.07 kilowatt-hours per lamp installed per year—as was the average in the case cited—the cost for the same will be

$$\$0.03475 \times 341.40 = \$11.86 \text{ or } \$0.98 \text{ per month,}$$

and the total yearly cost, \$42.67; and a monthly cost of \$3.55.

The equivalent flat rate for the particular load is easily found to be 12.48 cents per kilowatt-hour.

The short-time consumer with a connected load of 20 lamps will have a minimum monthly bill of \$2.57 and thus bears his share of the readiness-to-serve charge. The system is clearly superior to some others in that it makes an equitable distribution of fixed expenses and encourages the long-time consumer so

desirable in improving the load factor and hence the plant efficiency.

This is a theory of rates based on costs—at least as far as the central station costs are involved. It averages the cost of service and therefore makes an unequitable distribution of that item.

The consumer would actively resent the payment of the minimum monthly charge of $2.57. He would fail or decline to see the justice in a yearly charge of $30.81, even though he used no energy, or was charged only 3.4 cents per unit for the energy he did use. It is clear that this rate system would be difficult of introduction in the ordinary city and an educational campaign would be required to convince the rank and file of consumers that they would be receiving fair treatment under this method of rate making. It is doubtful if the system in this form could be introduced with any resulting satisfaction to central station and to consumer; or even introduced at all, no matter what its merits may be.

It is therefore certain that an arbitrary redistribution of the components of the minimum charge must be made and as an example we may consider the following. Determine the minimum monthly charge of the energy is sold at 7 cents per kilowatt-hour which is twice the former rate. This will result in an increase in revenue from energy of $10,874.81 and with a consequent reduction of $12.08 in the minimum yearly charge and the minimum monthly charge will therefore be $1.56 against $2.57 in the former case. The energy charge will be, for the same consumption, $1.99 instead of $.098 as it was before. Distributing the reduction proportionately among the three components of the minimum charge gives values to them as follows:

$ 6.27	chargeable as consumer expense.
1.81	chargeable as meter expense.
10.65	chargeable as demand expense.
$18.73	

Of course there are other ways of distributing these several charges so that the system may be more attractive to the consumer. All cases will not be possible of treatment by the same analysis. Each problem will require individual examination and solution.

From the preceding consideration of the various methods of charging we may say that a rate system will be satisfactory in practice when it encourages the liberal use of energy compared with the maximum demand of the patron; when it is easily understood and gains the confidence of the user; when it prevents fraudulent use of energy; when the accessory apparatus, meter, etc., is cheap, reliable and the accompanying clerical work is not unduly complicated.

As concluding examples of rates made by large central stations the following may be given:

When Chicago's new City Hall was completed a few years ago bids were asked for supplying the electrical energy needs of the building. The equipment consisted of 15,000-16 c. p., 115-230 volt, 56 watt lamps, or the equivalent, requiring 150,000 kilowatt-hours per year, and 1200 horsepower in motors in 230 volt direct current circuits, consuming 450,000 kilowatt-hours per year.

The Commonwealth Edison Company made a price of 2.59 cents per kilowatt-hour for power and 3.09 cents per kilowatt-hour for lighting, on a basis of furnishing free renewals of lamps and on an average use of the combined maximum demands of both the light and power loads for 7.2 hours per day.

The Sanitary District Commission, operating an hydro-electric plant on the Drainage Canal at Lockport, gave a price of one cent per kilowatt-hour without renewals and 1¼ cents with renewals. In addition there were certain circuit demands or privileges made by the commisison.

The Laclede Gas Light Co. of St. Louis supplies electrical energy at the following rates. Alternating current at sixty cycles is used for lighting and the first two kilowatt-hours is charged at 12 cents per unit, the second two kilowatt-hours at 10 cents each; the next four units at 7 cents and all the rest of the monthly consumption at 4 cents per kilowatt-hour. There is a 5% discount for prompt payment. The minimum charge is $1.00 a month.

Motors are on 500 volt circuit and a minimum charge of $1.00 per month per horsepower of demand is made. The first 100 kilowatt-hours are charged at 10 cents; the second 100 units at 8 cents; the third 100 units at 6 cents; the next 300 units at 4 cents, and the remainder of the monthly consumption at 3 cents.

INSURANCE AND THE INSURANCE ENGINEER.

BY A. M. JENS*

As community life became more common and communities became larger, man began to realize the necessity for securing to himself and those closest to him some recompense for loss or damage. From this desire to make sure of recompense and, later, from the demand for security in a commercial way, arose the business of insurance. With the increased complexities of modern business and the increased necessity for making secure, there has developed insurance to match every new phase, until today the most common are:—

Life, Accident, Health, Fire, Tornado, Marine, Hail, Liability, Automobile, Plate Glass, Burglary, Rents, Use and Occupancy, Profits, Leasehold, Bonds, Boiler, Tourist Floater, Sprinkler Leakage, and Parcels Post.

Of these different kinds, that of fire insurance is most closely identified with all other branches of commercial activity, and for its success requires a great knowledge of all the details, processes and conditions affecting other businesses.

While other lines of insurance may call for detailed and technical knowledge of conditions and may thus require the services of engineers to a certain extent—as, for instance, liability insurance with its recently-developed safety engineer—in none of these branches of insurance is the demand for engineers so great as in that of fire insurance. Thus when we speak of insurance and the insurance engineer, we ordinarily have in mind fire insurance and the fire insurance engineer, and it is with this particular phase of the subject that we will deal.

HISTORY OF DEVELOPMENT

It is interesting—if not essential—to study the growth of the business and the development of the demand for details which eventually brought forth the insurance engineer.

*With Fred S. James & Co.

While there were earlier records of attempts at fire insurance, all more or less mutual in character, it seems to be generally agreed among writers that the business as we know it today dates from the time of the London fire of 1666. Immediately thereafter individuals, and, later, companies, began to offer fire insurance.

The business of insurance as conducted in those days was based purely on chance. In the history of marine insurance, for example, we read of the sportive gentleman sitting on the dock and calling after a departing master a wager that the vessel would not return. So in Fire Insurance the insurers simply said, "we will gamble with you that your property will not be damaged or destroyed by fire, you pay us a premium and, if the property burns, we will return the premium a hundred-fold."

Gradually the insurers began to see that there were opportunities for reducing the element of chance and for throwing the equation into the law of averages. Then came the demand for information, especially in connection with the physical qualifications of a risk, covered today under the subjects of Rates, Exposures, Occupancy, Construction, Hazards and Protection.

First Came Protection.

The use of underwriting judgment was beginning to be exercised and perhaps the first step taken by the companies in England toward the elimination of chance and the recognition of factors entering into the equation had to do with the item of protection. It was the custom in those days to indicate the house insured by means of metal house plates securely fastened to the front of the building, and then to hire a man to patrol the district, providing him with simple hand apparatus in the way of buckets and axes for extinguishing fires in buildings bearing the house plates of his employer. Later the companies provided uniforms for their firemen, established bucket brigades and provided hand-pumping engines. They then organized corps of watchmen and patrolmen who, in case of fire, summoned the firemen of the company for whom they worked. To prevent the spread of fires, it was customary to blow up the buildings with gunpowder, this work usually being done by the artillery. As the companies began later to insure personal property, they organized salvage

corps for removing insured contents from burning buildings and for protecting these contents from further loss or theft.

The fact that firemen would disregard other risks and bend their greatest energies to the protection and salvage of the particular risk in which their company was interested, led to considerable agitation among the companies themselves and the result was that the various salvage and fire corps of the several companies were consolidated and, at a later date, turned over to the city. In London this did not take place until 1866. In the United States, as in England, the first steps toward providing fire protection were taken by the companies and later came volunteer departments which gradually developed into the municipal fire department and fire prevention bureaus of today. In this latter division especially is there a new and increasing demand for the services of the Insurance Engineer.

The development of the salvage corps followed closely that of the fire department; in Chicago, for example, we learn of the organization of a volunteer salvage corps as early as 1856, culminating eventually in the Insurance Patrol of today with its eight companies. These salvage corps have remained almost eneirely under the control of the insurance companies and the efficiency and availability of these departments is an item which must be considered in passing underwriting judgment today.

Entrance of the Exposure Feature.

The development of the technical detail of the Insurance Business in the United States was perhaps more rapid than in England or other foreign countries, for the range of possibilities and contingencies which may arise to influence underwriting judgment always has been and probably will continue for some time to be greater in our country. After protection came the recognition of the factor of exposure, which appears in the organization of the first American fire company, the Philadelphia Contributionship, in 1753. This company decided not to insure houses having trees planted before them. This decision being based probably on the theories that trees attracted lightning and that they might also interfere with the fighting of fire. To this business policy there developed considerable opposition, resulting finally, in 1784, in the formation of the Mutual Assurance

Company, which adopted the green tree as its emblem. Incidentally it might be mentioned that both companies are still in existence and transacting business along the lines of perpetual insurance, although they probably no longer give extensive consideration to the question of whether or not trees are planted in front of the insured risk.

Hazards, Construction and Rates.

As near as can be ascertained, the recognition of other factors entering into the underwriting equation came in 1794, when the companies began to consider hazards, construction and rates. They divided risks into two classes—the first including common hazards and providing for brick or stone houses and stores and the contents thereof. This class was written at a rate of 30c per hundred on a policy not exceeding eight thousand dollars, and 45c per hundred on a policy over eight thousand dollars and not exceeding sixteen thousand dollars,. The second class of risks included thoses which were not built entirely of brick and stone and such extra-hazardous goods as pitch, tar, turpentine, rosin, etc., the rate on this class being 75c per hundred.

About 1800 the companies began to make specific rates on individual risks—for example, we read of a building in process of construction insured for $4,000 and written for three months at a rate of 12½c also $10,000 on a gin distillery at a rate of $1.25.

Agencies and the Special Agent.

The questions of rate and desirability from an underwriting standpoint, determined today by the inspector, the engineer, or the other experts, were in early days decided upon by the directors. As these officers and directors went about getting information the companies began to desire to distribute their liability more and to obtain more detailed information on the specific risks.

In 1807 one company had established an agency system and was operating in nine states. In 1825 another pioneer company established a western department in Cincinnati and began planting agents throughout the territory. This was the beginning of the general agency system and also created the demand for spe-

cial agents, their duties at that time being to establish agencies, adjust losses and maintain collections.

About the time of the great New York fire of 1835 companies began to classify risks to enable them to determine their desirability. As an aid in remitting information, especially in congested districts, block sheets were made, and in 1856 we have our first record of a fire map. In 1867 the Daily Report was originated by Alexander Stoddard, this report being the company record of the policy and contained the name of the assured, term of the policy, amount of premium, general description of property, together with exposures if any. The furnishing of this information to the companies seems to have awakened in them the desire for more detailed information, especially in connection with that class of risk with which they were not entirely familiar, and they began calling on the special agents to furnish this information in addition to carrying out their other duties.

Rating and Inspection Organizations.

The companies began early to realize the desirability of maintaining uniformity in the matter of rates and, with this object in view, they organized The Salamander Company in New York in 1819. This organization was followed by others in the period between 1830 and 1840 and various attempts at standard rating were made. From these attempts at organization and uniformity in the matter of rates there has developed the present-day rating and inspection bureaus. The Chicago Board of Underwriters of Chicago, for example, one of the most efficient organizations of its kind, was formed in 1856, incorporated in 1861, and, after passing through various periods of success and in activity, is today well established with two Superintendents of Rating, three Assistant Superintendents of Rating and a Chief Surveyor, with thirty-seven Inspectors, any one of whom may make for himself the opportunity of becoming a recognized engineer.

The development of rating and inspection bureaus seems to have received special impetus with the organization of the National Board of Fire Underwriters in 1866, the purpose of the organization being to bring about among the companies better cooperation to secure uniform and adequate rates, together with the use of uniform policy contracts.

The Chicago fire of 1871 followed by the Boston fire of 1872 put many companies out of business, and reawakened among the survivors the desire for a uniform system of providing adequate rates and detailed reports as well as for general improvement in construction. This created the demand for inspectors and the organizations were called upon for detailed information in connection with rates and physical construction of risks.

Also at this time the so-called "Mill Mutuals" began an aggressive campaign for business based on the prevention of fires rather than the payment of losses. This resulted in the development, not only of inspection service, but of prevention devices, the most important of which—the sprinkler system—was first put into practical use in the early 80's.

First Appearance of the Engineer.

About this time the development of business of all kinds and the creation of new industries, with the consequent multiplicities of hazards, created the demand for men of special technical knowledge, and about 1890 we began to hear of the insurance engineer. He was at first a graduate of some other branch of engineering to whom this part of the business of insurance appealed. The study of insurance engineering was not then considered of sufficient importance to warrant courses in our technical colleges, the first definite acknowledgement by such institutions that the subject was an important one came with the establishment of the present course of Insurance Engineering at Armour Institute of Technology in 1903.

In the historical sketch of the Chicago Board of Underwriters we read: "At meeting held January 14th, 1890, the employment of an electrical expert, to inspect automatic fire alarm systems, electric light plants and other electrical appliances was considered. In 1893, Mr. W. H. Merrill was employed as such expert, with whom was associated Mr. W. C. Robinson as hydraulic engineer; the result of this action has been the Underwriters' Laboratories, whose operations, covering the entire range of fire protection and fire prevention apparatus, extends throughout the United States."

About 1900 the companies began to establish special risk departments to take charge of the insurance on sprinklered risks,

fireproof buildings, light, heat, power and gas properties, packing plants, etc., and the demand for engineers to furnish the desired information to these departments was greatly increased.

THE INSPECTION REPORT

To give some idea of the general knowledge demanded of the engineer and the information necessary in the underwriting of a specific risk, the following outline of the data required in a comprehensive inspection report is given:

Name—Individual, Corporation or Partnership.	Date.
Address—Legal Description.	Map—Volume and Page.

Rates

Gross Rates on Building, Machinery, Electrical Apparatus, Furniture and Fixtures, Stock.

Various Coinsurance Credits, if any, and if coinsurance is permitted by law.

Conflagration advance if applicable.

Term rates applicable to building and contents.

Exposures

Possible conflagration hazard. External exposures in the sense of buildings other than those in the same plant or under same ownership—Internal exposures; protection against exposure, in the way of wired-glass windows, iron doors and shutters. Communications—through single fire doors, double doors, vestibule, passageways.

Occupancy

Details by floors, sections and tenants. Railway cars adjacent, detached sheds and outbuildings, and yards.

Construction

Height. Area. Roof construction. Roof structures—texas, skylights, cooling towers, tanks. Walls—brick, frame, iron-clad, brick-veneered, cement block, tile, skeleton steel, concrete; finished, sheathed, insulated, or forming interior divisions. Floors and floor supports, steelwork protection. Ceilings—open, whitewashed, sheathed. Partitions. Galleries. Floor openings—stairs, elevators, chutes, well holes, belt holes; how cut off. Exterior attachments—additions, sidewalks, sheds, passageways,

canopies, platforms, signs, awnings. Possible exclusions from form—foundations, vaults, pits, excavations, reservoirs.

Hazards

Heating device—fuel, chimneys and location, ashes. Lights—electric, outside or private source; gas, public supply, artificial or natural; gasoline, acetylene, compressed gas, kerosene vapor systems; lanterns, lamps, torches, candles. Power—boilers, engines, piping, generators, motors, gas and gasoline engines, and refrigerating apparatus. Miscellaneous—quantity, location and method of handling benzine, gasoline, benzole, naphtha, kerosene, dynamite, ether, fireworks, greek fire, gunpowder exceeding 25 pounds in quantity, nitro-glycerine or other explosives, phosphorus, or petroleum of any of its products (especially if of greater inflammability than kerosene oil of the United States Standard), furnaces, ovens, dry rooms, ranges, blow torches, kettles, vacuum pans, roasters, incubators and brooders, all incidental hazards with chemical and mechanical arrangement and use, automobiles, cuspidors, oily waste, greasy clothing, cleaning-up periods, and smoking, especially by employes.

Protection

Sprinkler equipment—wet, dry, supplies, valves, alarms. Town protection, street grades. Private departments. Watchman—private or central station. Hand apparatus, chemicals, standpipe and hose, water barrels and pails, sand pails, tarpaulins, steam jets, fire escapes, and ladders.

Summary

Gist of the above with mention of features entering into moral hazard, probable changes, any leases, incumbrances or special contracts, such as railway waivers, affecting policy contract, items of importance specifically excluded or others included where ordinarily excluded, desirability of class, and, finally, net lines recommended.

From the Summary it will be noted that there must be considered not only the physical but the moral hazard, some of the points to which the engineer must give answer being—Is risk properly located; is raw stock available; is there demand for output; are labor conditions favorable; is management intelligent;

are equipment and processes modern; and also what has been the loss record?

THE ENGINEER OF TO-DAY

The insurance engineer of today may be employed by rating and inspection organizations, by insurance companies, local agencies, brokers, large corporations or by fire prevention bureaus of fire departments, or he may be engaged in special engineering work such as is carried on at the Underwriters' Laboratories, but always his work has for its object the elimination of chance and the making of accurate underwriting more possible.

The broadest field for his services seems to be with the insurance company or the large local agency.

He must be prepared to visit risks of every kind, from the large packing plant with its multiplicity of hazards and underwriting features to the small dwelling, to ascertain whether it is of brick-veneered or brick-and-frame construction. He must expect long, tiresome trips away from his fireside, with days of hard labor and nights spent largely in finishing up one day's work and preparing for the next. He must learn to adapt himself to every condition and disposition; he must combine tact with politeness and the firmness of self-respect. Not only does he need to be an engineer with a working knowledge of electricity, mechanics, hydraulics, physics and chemistry; he must be a student of human nature and, in keeping with the recent trend of state regulation, it would seem that he must study law as well. He must be a salesman, and, last but not least, he must be a good reporter, especially in the sense of being able to clearly, intelligently and concisely express facts and his judgment thereon.

Just a word of advice to the young man who is fitting himself in a technical institution for the profession of insurance engineering: Pay more attention to English, to Logic and to similar studies, so that you may become a better reporter, a better salesman, and perhaps some day a more able executive.

THE OUTLOOK

When we stop to think that in the United States and Canada the fire losses for 1914 were $235,591,350 as compared with $224,723,350 in 1913 and $163,362,250 in 1900, that the premium in-

come for 1914 was approximately $320,000,000 with an average rate of $1.01 (as compared with $1.03 in 1913, $1.05 in 1912, etc.), then will we realize the permanency and importance of the business of fire insurance.

The field of insurance engineering is growing larger every day. In Use and Occupancy Insurance, covering fixed charges and loss of profit, the demand for his services will greatly increase, for each individual risk needs special treatment and no sane or just method of rating has as yet been established.

Recent decisions of the New York courts show a tendency toward the Code Napoleon, and people are consequently going to require the services of the fire prevention engineer, not only for their own sakes but for that of their neighbor's as well.

Further, when we consider that the loss ratio in the United States for 1914 was 58%, and also when we realize that the per capita loss is approximately two dollars, as compared with twenty cents in some foreign countries, then will it be seen that the engineer has before him a great work of conservation and the profession will receive the full recognition which its importance deserves.

THE FUTURE OF AMERICAN HIGHWAYS.

BY H. J. ARMSTRONG*

The interest in highways shown by people in the present generation is so general that one would have to search long to find a person so benighted as not to appreciate the value of good highways. We may safely say that every man, woman and child in the country is vitally concerned, and should be deeply interested, in highway development.

It may not be amiss to restate at the outset some of the advantages commonly claimed for good roads, together with some others not so generally appreciated; and by advantages we mean proven advantages, the results of world-wide experience.

(a) In any given community the building of good highways accomplishes a social revolution among the people served by them. When people can have their daily mail brought to them over a good road by a R. F. D. carrier, and can send their children several miles over a good road to a centrally located and well-equipped large school, and when a trip to town in the spring of the year is no longer a slow and perilous journey, the gain to humanity has been great and far reaching.

(b) Good roads enable the farmer to ship produce to market at the most favorable time.

(c) Economists agree that the cost of distribution is a large factor in the cost of living. When it is considered that a very large percentage of the world's commerce starts to its destination on wagon roads, and in many cases reaches the ultimate consumer by a wagon haul, the economy of good highways is self-evident.

(d) Good roads increase the value of property served by them. We see examples of this everywhere, in city and in country. Accessibility is an important item in property value. More and more in our modern civilization we are using the time unit instead of the distance unit to measure accessibility: we speak of two cities being so many hours apart, not so many miles; a man speaks of his home as being so many minutes from his place of business.

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The agencies existing for the promotion of good roads are many. The past few years have witnessed the organization of several associations which have for their object the stimulating of interest in highways, the discussion of engineering questions relating to construction, the standardizing of practice in matters relating to construction and administration, and the influencing of proper highway legislation. They have included in their membership contractors, engineers, and many government, state, county and municipal officials. There are many associations of automobile owners and automobile manufacturers, all of which have been active in good roads agitation. It is claimed by many that the advent of the automobile has been the largest factor in the present agitation for good roads. Several magazines are now published, devoted exclusively to roads and streets, and if one may judge from the amount of space devoted to highways in the standard engineering periodicals, the subject is evidently of great importance. Railroads in some parts of the country have considered it good business to run "Good Roads Specials" as well as "Better Farming Specials," the one supplementing the other. The U. S. Office of Public Roads has for many years been engaged in investigating road problems, testing road materials, and lending its aid to road builders in many ways. The majority of states now have State Highway Commissions in one form or another, engaged not only in building roads partly with state funds, but aiding communities in other ways to advance the interests of easy communication. All these agencies are likely to keep very much alive, and to increase in number and influence.

There are a number of questions of vital importance connected with the future development of highways, which are being discussed among engineers and various officials directly concerned in the construction, maintenance, and administration of highways. These questions have for the most part originated within the past few years by reason of the rapid development and changing conditions in modern civilization. Rapid development has meant increasing need for highways, and the need for wise decisions as to the types of construction adopted: changing conditions have raised vital questions concerning financial and administrative matters.

It seems probable that in the future there may come into being new relations between the railways and highways. Railway development in this country has been one of the marvels of the world in its extent and influence: very early in its history it eclipsed the road and canal building, so that at the present time the amount of competition between them is insignificant, especially in the case of canals. In the case of highways, however, the future may have surprises in store for us. Granted the construction of suitable highways and the use of motor trucks with a capacity of perhaps one-third or one-fourth that of the present-day freight car, operating over fixed routes for distances up to say fifty miles,—it is not hard to believe that the highways of the future may occupy a new position with relation to the public welfare. Indeed this very thing is already taking place to a considerable extent in the substitution of motor truck suburban express for that which was formerly handled by the railroads. It is claimed by some in a position to judge that the railroad development in this country has passed its high-water mark, and that the future mileage constructed will consist mainly of short connecting lines and "feeders," and not long trunk or main lines. This seems like a reasonable prophecy, and might even be understood to include the construction of electric lines.

If, then, the motor truck is to take from the railroads some of the business which they would otherwise handle, and if, in addition, as undoubtedly will be the case, the motor truck develops considerable business by itself, the question of providing the proper roadway arises. Certainly the simpler types of construction will not do. Someone has facetiously remarked that "the automobile has not given us better roads, but has taken from us even the few good roads we had." This is merely a way of emphasizing what all highway engineers have come to know, that automobile traffic is very destructive to the ordinary macadam road, which formerly was a standard type of construction, but which of late has been very largely superseded by various types of bituminous macadam. In recognition of this destructiveness special taxes have been levied on automobiles, similar to the ordinary wheel tax in cities, although Massachusetts is the only state as yet which taxes automobiles according to their horsepower, after the English system. Funds collected in this

way are usually applied towards maintenance of highways, and not on new construction.

Let it be emphasized right here that whatever type of roadway may be evolved for the heaviest motor-truck traffic, it must be a *roadway* and not any sort of a trackway, for the moment we consider a trackway, we lose sight of the flexible feature of a roadway which enables a vehicle to go anywhere, and to turn out at will, as occasion may require. In this connection it may be well to recall that in the early history of railroad building, before the locomotive was perfected, the experiment was made of building a track and throwing it open for public use just like any highway, to be used by anyone who had a team with the vehicle of proper gauge. Needless to say this experiment proved a failure.

It may be that the future will see the construction of highways built especially for heavy motor traffic, from which other traffic is excluded or admitted with restrictions, just as now we have boulevards on which no heavy traffic is allowed. It may be that some of this heavy traffic will be moved by means of trains of two or more specially constructed trailers drawn by a single motor car. It has been suggested that we may see in the future the adoption of motor buses in our streets in a way similar to the common practice in some European cities. If these things come to pass, the types of construction will be influenced by them.

The problem of financing the highways of the future must receive careful attention. There are many instances existing of inequitable apportionment of costs for road and street improvements, due, often, to antiquated laws which no longer serve the purpose for which they were originally intended because the conditions have changed so greatly. Cities, counties and other civil subdivisions have to be governed by state laws in such matters, and these laws vary greatly in different states. The amount of state aid in the construction of state roads varies widely also.

Besides the equitable apportionment of highway costs, there are certain other features of financing and administration deserving of careful consideration. The issuing of bonds to run for as long terms as 30 to 50 years is pretty generally conceded now to be an economic fallacy, if these bonds are to pay for the more ordinary forms of improved highways. Only a part of the

work done in building a new highway represents a permanent benefit or investment, the remainder has to be replaced in a few years. The experience of New York State in the past few years should serve as a guide (and a warning) for other states contemplating extensive highway improvements. This state issued bonds to the amount of 50 millions of dollars, to run for 50 years, and the results of the work carried on have fallen much below expectations, for many of these roads have already worn out and must be rebuilt. In a recent investigation it was found that much money had been wasted, due quite as much to inefficient and unscientific organization as to dishonest work and political interference.

While state aid in highway construction seems to be a settled policy in so many of the states, we find that government aid in late years has not extended to actual construction work. In the early history of the United States a policy of government road-building was inaugurated and a number of highways were built, the most notable of which was the famous Cumberland Road from Washington, D. C., to St. Louis. The work on this road was carried on for some years by congressional appropriations, but the western end was never completed, and in later years the entire road was turned over to the various states through which it runs. It is claimed by many people that there is as ample warrant (constitutionally and otherwise) for the government to improve roads as to improve rivers and harbors, and yet it must be realized that the cases are enough different to afford plenty of opportunity for argument. At nearly every session of Congress in recent years, appropriation bills for road construction or improvement have been introduced, but as yet nothing substantial has resulted. In February of 1914 the Shackleford bill passed the House of Representatives, but has not yet passed the Senate. This bill provides that the government shall pay to the states as aid in road improvement, from $15 to $60 per mile according to the kind of road, provided that the states spend at least an equal amount. This, of course, would go toward maintenance rather than new construction. More recently a bill has come up in the Senate providing for government aid which shall consist of an exchange of 3% government bonds for 4% state bonds,

the government in this way lending its credit and being reimbursed by the difference in rates.

About two years ago there was formed the National Highways Association, composed of a group of men interested in highway development. To quote from the literature sent out by this organization,—"The purpose of the Association is to promote discussion, disseminate knowledge, and assist as to the best development of highways. The Association believes that the most beneficial results will be obtained by first securing the building and permanent maintenance by the Federal Government of approximately 50,000 miles of highways throughout the United States as a great system of National Highways, and next, to encourage the building of *good roads everywhere* as the distributing and collecting medium for the traffic of the National Highways." This mileage of roads they show on the map as "Main," "Trunk" and "Link" highways. This is certainly an ambitious scheme, and one which we can depend upon to furnish prolonged discussion and argument before becoming a government policy or program. Much more than we need through route highways, we need systems of short roads radiating from the centers of population and it is likely that the states and local authorities will concentrate their energies on the improvement of these roads first of all, for these are the roads which affect the welfare of the largest number of people.

The opportunities for engineers to engage in highway engineering are increasing. While not a very large field as yet, it gives promise of growth into one of the largest and most important branches of civil engineering. The government bureau and the state commissions will both undoubtedly employ more men as time goes on, and under the improved systems of state and county operation, the county engineer's position will become one of increasing importance. Formerly, in many cases, the county engineer has been little more than a land surveyor; now he has become an engineer with responsibility for important roads and bridges,—for better bridges and culverts necessarily go with better roads. It is not at all uncommon to find that highway work in some counties is of such importance that the new position of County Highway Engineer has been created. Judging from the work already done by our pioneer highway engineers,

we may be sure that this branch of engineering is worthy of the highest skill. There is need of as great, or greater, skill in selecting the proper and economical types of construction, as in supervising the construction itself. The problem is to build the road having the smallest total annual cost, and in the solving of this problem the engineer must apply fundamental principles of economics and finance. Engineers have too often in the past been placed in the position of having to build structures with funds insufficient for the most economical construction, and then later when these structures have failed or have not given satisfaction, the reputation of the engineer has suffered. With increasing interest and information among the general public concerning highways, it is to be expected that this condition will be much improved in the future.

THOUGHTS ON EFFICIENCY STUDIES

BY E. F. HILLER*

At the beginning of their school work, students in engineering courses are taught to realize that to design structures or machines they must study and determine upon units or standards for measurement, for strength of material, for specific gravity, for intensity of light and sound and for other attributes of matter involving mathematical analyses. Because the duties of the so-called "efficiency expert" require the analyses of conditions of work and the setting of standards which will serve as measurement of these factors (although in many cases not requiring an engineering education for their proper understanding) it follows that the leaders in this work are recruited principally from the ranks of engineers rather than from those of other professions.

Young engineers should realize, as many of them fail to do, that their profession does not concern itself principally with design and construction; that they who rise highest are really executives whose main work it is to instruct and to call attention of others to various features in design or construction for which provisions must be made. The work of the executive concerns itself principally with the questions of how well, how economically, and how quickly the forces under his direction perform the duties required of them.

Taking cognizance of these facts, the engineering student should realize the importance of proper training for the work which confronts him. To obtain it he should carry on his collegiate work under such a system that he will be enabled to inculcate, without materially adding to his work, the principles of standards determination. Such a system requires a proper analysis, into the important factors, of the work being performed, together with the maintenance of records thereof.

Advantage must be taken in the study of the factors and their relation to each other, of the principles set and results obained by the pioneers in efficiency work. These leaders have made great strides in improving conditions in such institutions

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as machine shops, where the large number of similar and long continued operations performed by various groups of employes on machines has made it possible to mathematically analyze the cost and efficacy of work done and to discover and eliminate waste time and lost motions. They have been enabled thereby, in cases where human attainment is governed by machine capacity, to set tasks which may reasonably be expected of machine operators. They have also extended the system to cover those human activities which partake of the nature of machine work rather than of work of the brain.

It must be conceded that the great improvements that have followed in the work of such producing forces indicate great steps in advance over the old methods which have been too long the custom, through which employes were permitted to perform their work without sufficient instruction, without adequate check as to quality and economy of operations and without proper correlation of the work of one to the other. There still remains almost a virgin field in these principles of standard setting and work measurement in application to the efforts of those whose tasks are such that they do not at the present appear to lend themselves readily to such exact analysis.

The same factors of analysis apply to the work of both classes of employes. Consider, for example, a large manufacturing concern, which includes an executive force, a sales force and a shop force and in which the work of the latter branch has been standardized. It is a reasonable assumption that the cost of the first two forces approximates that of the shop force. Is it not then necessary, in order to place the entire organization on an efficient basis, that the so-called "indirect costs" of these forces may be subject to study and standardization? Is the problem of efficient organization and work fully solved if this is not done?

Some slight progress has been made with the problems of the sales force. A salesman who can show that, in volume and amount his sales have increased over his previous year's record or over those of his predecessor is assumed to be a more able man, and consequently he has little trouble in getting the company to advance his salary. Similarly, the efficiency of the manager of a sales force is based upon the total sales of all employes under his direction, but in very few concerns are the records in such shape

that the amount of sales are a true indication of the efficacy of the force. Proper analysis has not been made to show what deductions should properly be charged against the sales force account, such as for increased advertising expenditures, additional rental and other overhead costs due to expansion in the sales force. If any of these expenditures increase in greater proportion than the amount of sales, without a corresponding lowering in the sales cost, it follows that the efficiency of the manager or force under consideration is diminished. Often the records are not complete enough to show whether or not a gain in sales for a period has been made at the loss, by misrepresentation or other unbusinesslike practices, of future trade. In no case can the efficiency of a sales force be determined if any of these facts are not definitely known, or at least not so set forth as to admit of intelligent study.

The problem of efficiency study of the other forces of the assumed manufacturing company is that which is met with in large municipalities operating under a civil service system, in which promotion is based upon ascertained efficiency, and discharge from the service requires that charges of inefficiency must be proven against the employe.

The question is, in such services, what is efficiency and how far can an employe fall below the standard set for acceptable work before he becomes so inefficient that not only are his services undesirable, but he becomes a loss to his empolyer. In machine shop practice, as indicated previously, study might have shown that a mechanic should turn out 100 units of work each day, but that through lack of knowledge of the work in hand, or because of slowness he does accomplish only 80; his services then represent an actual loss to the company, inasmuch as interest and maintenance charges on the machine he uses and rental value of the space he occupies, together with his wages, require more work than he is able to produce, say 85 units, in order that there be no loss. In other words, he must be at least 85% efficient before his work is profitable to his employer; when his work falls below that point he must either accept some other position for which he may be fitted, or else be dropped from the service.

But in the cases of clerks or stenographers, or engineers engaged in field or designing work, all of whom are represented in

large numbers in an extensive municipal service, what is the unit of measurement, how many units of work may properly be expected of each employe, what is the minimum performance and for what period may such deficient work be accepted before dismissal is required? More important than these questions is that of how may efficiency be proven before a Civil Service trial board, in reality a court demanding proof of incompetence rather than the personal opinion of a superior officer who may be prejudiced.

If one inquires of any executive or foreman as to the work of three men, A, B, and C, under his jurisdiction, he may be told that A is a speedy and careful worker, B is also speedy, but so careless that his net output is much less than A's, and that C is so slow and careless that he represents a loss and should, therefore, be discharged. Usually that is done at the executive's recommendation. But such action is not possible in a civil service of the class under consideration; it is also not possible in a private organization which guards the rights of its employes against the oft exercised tyranny of some petty official with a grudge to pay.

On the other hand, it is extremely difficult, without standards of measurement, to separate justly from a service one whose only offence, however serious it may be, is inaptitude, lack of interest or laziness, or old age. Because of the absence of such standards, the impression is prevalent that upon entering a civil service an employe obtains a life job and the municipality is required to pay more than his services are worth.

In such cases, factors and standards for efficiency measurements are extremely important. But without much study the setting of these is difficult. For example, in consideration of the work of a stenographer, what weights should be given to speed, to freedom from errors? How much of her worth is due to ease of expression, form, readiness to serve? In considering the work of executives, which one should be rated higher, he who, getting much work out of his force, comes late, leaves early and keeps it in a nervous state at all times, or the other who works along quietly with his force, though not obtaining so great immediate results? How can a measure be set for the value of the work of each?

This problem must be solved if we would progress along the

right lines. Many will say that no solution is possible; the writer, while not claiming that exact results are obtainable in all cases, still is of the opinion that sufficient study under well defined conditions will, as in other sciences, do much to set more clearly the limits of efficient and of inefficient work. An excellent start has been made in the mechanical trades. Let the principles and methods be broadened and extended to those trades and services which heretofore have been considered unmeasurable.

In order to ascertain the method of attack it must be understood that this subject is a science and the manner of study is to make tests, not infrequent and incomplete, but continuous, and with all attending conditions known and defined. Each student of engineering, to take an example close at hand, in order to determine his efficiency as a student, should throughout his college career, keep in some systematic form a closed record of all his activities, detailing the time spent in the class room, in prepatory study, in recreation and in rest, as well as in those pursuits which cannot be definitely allocated to any of these activities. In this accounting it is evident that the time spent in the first two, i. e., in class and preparatory study, are the principal elements and that his efficiency as a student increases as the percentage of time thus spent increases. Inefficiency should be first looked for in the item of "time which cannot be definitely allocated" and efforts made to reduce this as far as possible. A further study should also be made to determine the efficacy of the time spent in study with regard to certain facts about like the following:

1—The relation of time spent in study to grades received.

2—The reason for and amount of time lost in preparing for study.

3—The time required to prepare for examinations.

4—The time required to write up experiments.

5—The number of pages written in each report.

6—The number of square inches of each drawing made, and the scale thereof.

7—The amounts of materials shown on each drawing.

lowing factors, in line with those given previously would be a part of the record:

1—Time spent in study of the subject.
2—Number of problems assigned.
3—Number of problems correctly completed.
4—Final grade in the subject for the term.

The second and third factors are in most cases now used by instructors to determine the grade of the student; with the addition of the first and last, related to the others, his efficiency should be measurable. It is upon these that greater emphasis must be placed. A simple system of this sort will open the way and serve as a starting point for the more difficult measurements entering into less exact tasks.

A case of this more difficult work to measure is that of the executive in charge of a non-revenue producing department, such as a chief engineer of a railroad. It is true, almost without question, that engineers, whose work is usually expressed in expenditures rather than in receipts, notwithstanding they are highly educated and able and strong executives, receive far less compensation than their co-workers in the revenue producing department. This trouble lies in the fact that there are few, if any, standards by which the value of expenditure work (if it may so be called) is measurable. With the present system of records, it cannot be exactly known for years after completion of the work. If engineers are ever to receive salaries commensurate with results they achieve they must give time and thought to a system by which they can show their employers, without question, that by their expenditure of funds, recently made, they have earned for them a certain sum greater than their predecessors or than they themselves have earned in previous periods.

The keeping of adequate records require that units of measurement be set, and for the greatest good that the record forms be uniform so that comparison of results can be made between the work of the various students and between that of an individual on similar work at different periods of his school career.

Satisfactory results may not be apparent at the inception of this work, but this should not serve to discourage the student. If sufficient time is spent in obtaining properly planned studies and the results are collected and used in the proper way, they will soon become of value as a basis for more exact definition of correct relative, if not of absolute, measurements.

If conscientious work and constant thought is given, the procuring of these records should not interfere with the regular work, but should aid it. To secure reliable results it is necessary to give constant thought. The individual must train himself to untiring watchfulness in order that the proper entries will be immediately made. The mere fact that he is at all times attending to the subject of greater efficiency, will certainly reduce the waste of time. By delaying entering into records inaccuracies are sure to occur and spoil their value.

With the results of simpler studies in hand there will follow a solution of the more difficult ones including executive work, although it may take some time to discover and to standardize all the elements which enter. The first essentials, as previously mentioned, are the preparation of forms and their use for a term of years, the records thus obtained to be then compared and studied. For the more complex positions such factors should be included as time spent in actual performance of work, time spent in study, compensation received, labor cost on each project, and cost of materials, saving in cost of operation, or increase in revenue resulting from each job, as well as other similar facts.

Let a start be made by each one in the simpler matters of his every day study or work. Let each make of himself a subject of test. The more difficult problems of standard determination will then be subject to successful solution and in a few years definite information of true efficiency will be available.

ENGINEERING AND WAR*

BY LIEUT.-COL. W. V. JUDSON

Chief of Engineers, Chicago District, United States Army

The successful engineer is he who, at the least possible cost, directs the materials and forces of nature into channels useful to mankind.

Of all the professions civil engineering is most broadly based upon the exact sciences. It is the profession in which, from any point of view, mistakes are least permissible, for the reason that they are likely to be expensive of money or human life. Furthermore, the mistake of a civil engineer usually becomes evident sooner or later even to laymen and thus mars the reputation of its author. A lawyer may lose his case for a variety of reasons. Perhaps the weight of argument is fairly against him, and he is not blamed, at least not always, because he cannot make the wrong appear the right. Perhaps the court, which is only human, errs; or perhaps he fails because he lacks ability to present his case in its most favorable light. The public can rarely see the cause of the lawyer's failures and there are opportunities to correct them in other courts. The mistakes of preachers can only be learned beyond the grave, where lie buried the mistakes of doctors. But if a bridge falls down a child can take a photograph of some civil engineer's mistake. The second greatest general on earth may be beaten by the greatest, but all civil engineers must remain practically unbeaten or drop out of their profession.

In the character of a civil engineer there is no room for many of the picturesque foibles of human nature which do not militate against, but often win success, in other callings. With the civil engineer pretense of all kinds, including "bluff" and "gallery playing," is worse than useless. His work is always put to complete test in the full light of day and he must stand or fall by the result. The civil engineer must be thoroughly honest with himself. When solving a problem all the specious reasoning in the world will not add one pound to the strength of a material nor detract as much from the strains to be put upon a structure.

*A paper read at the mid-winter banquet of the Armour Alumni Association, December 19, 1914.

When honesty with self becomes a habit it is very certain that honesty toward others will follow. Nature, in accordance with whose laws the civil engineer prosecutes his work, accepts no bribes, gives no rebates and is not amenable to "pull." This probably accounts for the fact that the engineer does not become a millionaire. But it prevents the corruption of his morals.

I believe that the first requisite for a successful engineer is character; following that, habits of carefulness, accuracy, industry and observation. Now I am not talking in glittering generalities, for I do not believe that these same qualities are equally necessary in any other pursuit, although the reputation for possessing them may be. And incidentally one of the best things I can say of civil engineering is that while demanding these qualities it also cultivates them.

Civil engineering is the youngest of the learned professions. There were no technical schools in this country fifty-five years ago except at West Point, at which a very fair engineering education for those days was to be had as early as 1810, and Troy Polytechnic, which was instituted about 1824, but which did not become a full-fledged technical school until eight or ten years later.

The first trained engineers were military engineers, for the most elaborate and important structures built in great numbers during the middle ages were fortresses; and the most important events in those days were the attack and defense of fortresses, largely under the direction of engineers. From the early days of chivalry very high standards of honor have been imposed upon individuals following the profession of arms. Perhaps it is partly by reason of its military origin in the days of chivalry that the profession of engineering is today on so high a plane and to such an extent devoid of the chicanery that infests the other professions.

The work of the military engineer in general differs from the work of the civil engineer in that the former must provide not only against attack by the forces of nature but also against attack directed by all the arts of man. Often speed of execution is the first essential in his work, but on the other hand many of his constructions are not expected to be permanent. The principal work of the military engineer has had to do with fortifica-

tions, and, as war is of special interest in these days, you may be glad to hear something of the development and present state of the art of fortification.

Originally land fortifications had only to oppose the passage of individual soldiers carrying swords, crossbows or the like. An effective fortification was a wall, and the alignment of the wall was straight or curvilinear, depending upon its function. If it was to protect a town it surrounded that town and was called an enceinte. All developments from this simple enciente have been forced by the invention and improvement of artillery and of explosives. To prolong the time it would require to breach a simple wall by primitive artillery fire or by mining operations, the wall soon came to be reinforced by close-lying outworks known as redans, demi-lunes and the like; and to bring more fire upon attacking parties an alignment of the wall was adopted so that bastions resulted, and the fire from one part of the wall might sweep the ground in front of another part.

The further development of artillery subjected the protected area to destructive fire, but it was impracticable to remove the enciente far out to the front, by reason of the number of men that would be required to man the longer front. Furthermore, the defense was also provided with superior weapons so that it seemed (and was) an effective defense to build detached forts at intervals, surrounding the protected area at a suitable distance with a line of them. This was the approved fashion of land fortification some 25 to 50 years ago and toward the end of that period were built by the great engineer Brialmont the defenses of Liege, Namur and Antwerp. Brialmont was somewhat of an extremist. He made his forts very strong, with concrete and iron, and he armed them with artillery in cupolas, but he neglected the intervals between the forts. Even while he built, most engineers were coming to believe that the artillery should be mobile, moving where needed in the intervals and provided there with emplacements, concealed as far as practicable. They believed that the detached forts should be largely of earth, simplified, and manned almost wholly by infantry.

Fifteen or twenty years ago, noting the progress in ordnance, some saw that if the defense were congested in such units as detached forts, excellent targets for artillery fire would be af-

forded. They did not advocate an abandonment of intervals but a relief from congestion in the defensive units, making of the latter groups of small redoubts and trenches, each group covering a considerable area and called a fortified pivot. Such was the most approved theory of land defense some ten years ago, when the Russo-Japanese war began. During that war there was developed in the hard school of experience the system that is in present use on the battlefields of France and Poland. Further improvements in artillery, as demonstrated in the war in Manchuria, forbade even such congestion as existed in the fortified pivots. Intervals became dangerous by reason of the increasing employment of the night attack. The development of the telephone and the multiplication of its use in war removed objection to the scattering of the troops which formerly would have led to loss of control.

Much the same tactical considerations that led to the employment of successive skirmish lines in the infantry attack led to the present system of fortification upon the field of battle. The crowning principle of the present system is dispersal, but concealment is of almost equal importance.

A fortified line today consists of a zone, perhaps half a mile or more in depth, with many scattered pieces of trench work; some long and some short, in some sort of defensive relations one with another insofar as the ground permits; many provided with overhead cover of timber or boughs and earth to afford protection from shrapnel; where practicable connected with the rear by deep traversed or zigzag trenches; amply provided with telephone service, and the ground of near approach covered with wire entanglements and other obstructions. Toward the rear of the zone are the artillery positions, behind crests, forests or villages, the guns employing indirect fire, guns and detachments protected by earth cover and the projectiles passing over a portion of the infantry. Such a line, on ground fairly favorable to defense, and with some 4,000 good troops to the mile, is almost impregnable to frontal attack.

Where the defensive lines or zones are occupied, then there is a sort of equilibrium, the local defensive possessing great advantage. In places the hostile zones will approach each other within a few yards. Elsewhere they may be a mile or more

apart. Spaces between the zones will be swept by the fire of both sides. Siege operations will be in progress where the trenches are close together and here there will be sapping and mining and the use of hand grenades. During the night there will be occasional attacks, in efforts to make local adjustments of the zones, and for the same reason there will occasionally be furious bombardments, accompanied or followed by infantry attacks, in special localities.

When hostile armies meet there is a tendency for each quickly to occupy such a line along its entire front. Ordinarily an army thus intrenched cannot be driven from its position except by flank attack. Even a flank attack in these days of great numbers and long battle lines does not commonly produce disaster and thus lead to a decision. As a general rule there will be ample time for new dispositions to be made before a flank attack can either disorganize any considerable portion of an army so extended or threaten its communications.

When equilibrium has been established along a front, assuming that the flanks have been extended to neutral frontiers or other impassable obstacles, the life of the troops is not as difficult as might be imagined. A brigade of 4,000 men, for example, would be dispersed over an area extending perhaps a mile along the front and two miles from front to rear. But a small proportion at any one time would be on outpost duty or in the more advanced trenches as trench guards. The trenches would be fully manned only during infantry attacks upon them. Behind the trenches the supports would be fairly comfortable and protected from hostile fire, where possible, by over-head cover and by folds of the ground. Behind the supports again would be the reserves, who would soon provide ample shelter for themselves. There would not be much marching; and marching, with great loads upon each soldier, is probably the greatest hardship of war. Moreover, where there is not much movement the problem of supply is vastly simplified, and in trench warfare the troops are for the most part well and regularly fed.

The principal duties of the military engineer in field warfare are to select the lines for trenches and obstructions and to help construct them; to build bridges, both semi-permanent and temporary; to build or clear roads and railroads and sometimes to

operate the latter; to provide maps; to conduct siege operations, and to demolish bridges and other structures, including obstructions built by the enemy. In some armies he has charge of the telephone and telegraph. Often he has the post of honor, as when he is building a bridge across a stream held on the far shore by the enemy, or when he leads the pioneers against an intrenched position.

In time of peace one of the principal works of the military engineer is to build coast fortifications. The latter might more properly be called harbor fortifications. They may ordinarily be expected to act as complete deterrents to naval approach over the water areas they cover by their fire.

In time of war the government would need a vast number of volunteer engineer officers and troops. The best officers would be those practicing civil engineering in time of peace. It is earnestly to be wished that opportunity and inducement could be offered for a limited amount of work on the part of many civil engineers to qualify them for such service. It would be a useful thing if this could be worked out in Chicago. I am informed that Chicago has one of the finest engineer componies in the National Guard, and eight or ten Armour Alumni are members. Any other Alumni who appreciate the necessity of military training in time of peace cannot do better than to join this organization. The company is known as Company A, Corps of Engineers, Illinois National Guard, and its quarters are in the Battery B armory, Lincoln and Fullerton avenues.

A few years ago I had the opportunity of accompanying the Russian army during the campaign in Manchuria. Your ears are weary, for I have imposed upon you too serious a talk for after-dinner purposes. I shall conclude by exercising your eyes for a few minutes upon pictures I obtained during the Russo-Japanese war.

In advance I must warn you that my pictures are mainly of technical interest. One reason why they show little of the pomp and panoply of war is because pomp and panoply are no longer existent in war, but pertain principally to street parades, comic operas and the like. That part of a battlefield lying between two hostile armies is a desolate and lonesome place. Despite what you read in the newspapers, the enemy is rarely visible.

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There has been in the past few months, several requests for copies of the early issues of The Armour Engineer. The Editors are especially desirous of obtaining copies of the January and May, 1909, and January and May, 1910, issues for reference purposes.

The Editors request that anyone who may have copies of these issues they wish to dispose of, will please communicate with The Armour Engineer at an early date.

THE ILLINOIS WATERWAY

The Illinois Route was explored by Joliet and Marquette in 1873 and Father Dablon, 1674, relates the project for a short canal across the Chicago portage by means of which and the connecting rivers barques may pass from the "Lake of the Illinois" (Lake Michigan) to the "Floridas" (Gulf of Mexico). Narratives describe the route to the "Illinois Country" as one of the three principal routes for "trade and travel" between the Great Lakes System and the Mississippi River System. The French dreamed of an empire in the continental valley west of the Alleghenies, and between the Gulf of St. Lawrence and the Gulf of Mexico, a dream that was dispelled by the treaty of partition in 1783, extending the colonial domain to the Mississippi River.

The ordinance of Virginia, 1787, made the water trails between the lake and river system forever free. The Illinois Route was defined and protected by the Indian treaties of 1795 and 1816. In 1817, Major Stephen H. Long made a professional report upon the development of the route and it is further described in the report of Phillips and Graham in 1819, and delineated on the land plats of 1821. The northern boundary of the territory of Illinois was the parallel touching the south end of Lake Michigan and, when this state was admitted to the Union in 1818, this boundary was shifted northward 61 miles, 19 chains and thirteen links to the present limits in order to develop the Illinois Route within the confines of a single state and give Illinois a port on the inland seas. It was argued that Illinois would thus become a bond of commercial union between the two great basins, and thereby insure the perpetuation of the Confederacy.

Congress authorized a canal through the public domain in 1822 and made a land grant in 1827, but at that time there were neither settlements nor settlers north of the latitude of Springfield. Between 1832 and 1836 Indian titles were extinguished and the Indians removed from northern Illinois and Chicago had its beginning. Canal construction began at Bridgeport (the forks of the south branch) July 4, 1836. The canal was opened in 1848 and determined destiny for northern Illinois and Chica-

go. In 1885 it was estimated to have saved the people $180,000,000.00 in freight rates and is one of the public utilities of Illinois to get out of debt. In late years, however, its revenues have been insufficient for proper maintenance, pending the construction of an adequate waterway.

By 1885 the marvelous growth of Chicago and the character of its site made sanitary relief mandatory and the present drainage plan was outlined. The problem was studied and promoted to a solution in the legislation of 1889, and the Legislature wisely determined that the Main Channel, or outlet, should be so fashioned as to form a link in a great navigable waterway through the state and between the Great Lakes and the Gulf of Mexico, and the work has developed accordingly. The low water of Lake Michigan is 580 feet above mean sea level (Chicago Datum) and the original Continental Divide was an alluvial deposit 10 to 11 feet higher and located about 1,000 feet east of Kedzie Avenue and near the Bridewell, while the rock divide above Lemont was only 7½ feet above low lake level. In a distance of less than 30 miles from the lake shore, the valley of the Desplaines had descended to lake level and 10 miles further it reached 77 feet below lake level and in less than 100 miles it reached 146 feet below Lake Michigan at the head of the alluvial Illinois, near starved Rock, and opposite Utica. The immediate problem then was to cut the Chicago Divide with a canal which should carry an ample volume of water for dilution of sewage to the Desplaines River at Lockport. Such volume of water requires locks and dams and makes water powers over the steep declivities of the rock-bound valley between Lockport and Utica, while it makes possible the deep channel by dredging over the low declivities of the lower Illinois where the natural dry weather volume was very meager, from 500 to 1,000 second-feet.

The Drainage Canal, including the Chicago River, extends for 36 miles to the water power plant above Joliet with a depth of 24 feet and a width in rock cut of 160 feet at bottom, with vertical sides and a width in earth cut of 202 feet at bottom, with side slopes of two horizontal to one vertical. When this channel is fully developed in the clay at the Chicago end, with necessary adjuncts, it will have a capacity of 14,000 second-feet and be adequate under the law to dilute the sewage of 4,200,000

people, and this may increase to 5,000,000 or more through proper treatment or restriction of the trade wastes. This channel was opened for a preliminary flow of water January 17, 1900, and is now carrying about one-half its estimated capacity. This channel, and its collateral branches to the north shore and to the Calumet region and certain adjuncts, will be fully developed within a few years and it has been proposed to expand same into an inner harbor with slips east of Summit, and make a direct connection with the lake at some point south of Sixteenth St.

The adequate improvement of the Upper Illinois, between Lockport and Utica, will produce 173,000 effective horse power on the turbine shaft. This improvement has been considered for the same ultimate depth, 24 feet, as the channel across the Chicago Divide. In 1908, the people authorized the Legislature to appropriate $20,000,000.00 for the development of the deep waterway and water power over this stretch and in this work cooperation has been expected from the United States and other agencies so that the ultimate depth could be produced at an early date.

The Lower Illinois extends for 230 miles to the Mississippi River at Grafton, with a declivity of only 28 feet more or less, depending upon the relative stages in the Mississippi. With the volume of water provided for, the depth of 24 feet may be extended to Peoria and 18 to 20 feet thence to the Mississippi. Wholesale dredging will be required but a channel of greatly increased capacity is necessary, not only for the increment of water, but also to mitigate flood conditions and aid in the reclamation of some 700 square miles of overflow lands.

It will thus be seen that the Illinois project in actual process of development has been and is a fore-runner of a broad policy of conservation. In the one policy are combined sanitation for Chicago and the Illinois Valley, water powers, land reclamation and the deep waterway and, in addition thereto, are the increased salubrity of the valley and the development of the greatest river fisheries on this continent. What may be called the by-products of the waterway, the collateral developments above referred to, are estimated at over $300,000,000.00 in value without the waterway itself which will be estimated according to point of view.

Unhappily, when the Constitutional Amendment was author-

ized by the General Assembly in 1907, certain hydraulic parasites had located on the river for the purpose of utilizing the fruits of taxation for private gain, and a long train of litigation followed which has not been concluded in the highest courts. Again, interests about the Great Lakes considered themselves injured and proceedings have been brought to restrict the flow of water at Chicago to 4,167 second-feet, although a recent Federal report has estimated that any prospective damage of lake levels can be remedied for an expenditure of less than $500,000—an amount which the Sanitary District has offered to advance to the general government in the case at bar. It is expected and hoped that both issues will be decided at the October term of the Supreme Court of the United States in the year 1915.

Meantime, commercial interests have been strongly urging the opening up of the route for barge navigation on a depth of eight feet and have advocated the rehabiliation and enlargement of the Illinois and Michigan Canal. The committee of engineers named by the Governor has, however, recommended an expenditure of some $3,000,000 for a preliminary development of the river above Utica, in conformity with the deep water project certain side tracks into the canal at Marseilles and between Dresden below the mouth of the Kankakee, and Lockport, thus avoiding for the time being those parts of the river that are in controversy. About two-thirds of the river distance would thus be covered and the canal use would be further curtailed if the Sanitary District should be authorized to develop the Joliet level through the city of Joliet and down to the head of Lake Joliet. This development would contemplate locks of a width of 45 feet and a depth of 8 feet for the canal sections and only the junior locks for the river section, leaving reservation for the major locks.

Congress made a conditional appropriation of $1,000,000.00 for the deep waterway between Lockport and the Mississippi River in 1910, subject to an understanding with the State of Illinois. It is a part of the immediate program to make this appropriation available for dredging the Lower Illinois after the present dams have beeen removed but this may fail with the pending River and Harbor bill.

What it may be expedient to do for immediate navigation, in

conformity with some plan of progressive development to the ultimate end, will doubtless be considered in all its bearings at the coming session of the General Assembly. It is hoped that a program can be worked out pending the completion of litigation, or contingent thereon. In any event, the development of the river sections of the route in Illinois cannot be deferred for more than a year or two. —*Lyman E. Cooley*

THE VALUE OF A HOBBY

Success in any pursuit is secured only as the result of hard, persistent work, the motive for which is the sheer joy of accomplishment. Although success is variously defined, the above is, in the last analysis its true meaning. Whether we are dealing with success in terms of money or in terms of other accomplishments, material or mental, satisfaction with that which has been done is success.

It would be well for us all if through some fortuitous circumstance or through some definite study of our capabilities we could select those occupations which some can enjoy only as hobbies.

A vacation or a holiday is a change merely in the employment of the faculties; any change of this character is helpful as well as restful. Hunting, fishing, boating, the playing of games, and so forth, are not the only means for securing rest, but an avocation requiring the activity of higher mentality than mere sport will not only afford the rest required from the routine work, but in many cases it may lead to the development of the hobby into the life business and may lead to success in every sense of the word.

The manufacturer Joule, and the German doctor, Mayer, discovered the mechanical equivalent of heat; upon this work is laid the foundation of the law of the conservation of energy. Thomas Young, a physician, discovered the undulatory theory of light. William Herschell was a music teacher and never saw a telescope until he was thirty-five years old, but his hobby was to grind lenses and to make perfect mirrors, and ultimately through this hobby he discovered worlds, systems and universes. Our own Burnham became an astronomer and discovered thou-

sands of double stars while he was still a reporter in the United States Circuit Court. The discoverer of oxygen, Priestley, was a clergyman; Holmes of the "Autocrat of the Breakfast Table" was a professor of anatomy in the Harvard Medical School. Thus we might extend the list of celebrities who made models, wrote books, studied birds and flowers and did other things for hobbies which later developed into their life work for a considerable length, but we should not more forcefully point to the fact that success in all these cases was due to the hobby which soon lost its identity and became the vocation.

Therefore it is sufficient to show that enjoyment and relaxation may be obtained by the riding of a hobby, and while with some the hobby will be checkers, golf, ball, and so forth, with others the hobby will take other forms, and these latter, with their box of tools, their amateur machine shops, their music, their literature ,their miscroscopes and their telescopes are building for themselves, by these more intellectual activities, not only enjoyable and restful occupation, but they may even be making discoveries or laying the foundations for scientific advancements which shall be of the greatest benefit to the world at large.

—*Wm. Hoskins*

THE CHICAGO TRANSPORTATION PROBLEM

Of the many engineering and other questions requiring an early solution in connection with the growth and upbuilding of Chicago, none is of greater importance than the transportation question .

Years of study have been given to this matter; plans have been worked out and put in execution with promises of relief in this direction for years to come. There were to be no more straphangers. Capacity, speed and comfort were the watchwords. This was only a few years ago, and today the situation is as bad as, if not worse than, it has been at any time before. Prediction and promises made have not materialized. Transportation planners are again confronted with problems for relief measrues. Are we going to have some more makeshift solutions?

Those charged with the solution of transportation problems, we hope, will not again make the mistake of deciding upon relief measures that not only *will not* relieve, but that if carried out will also make a correct solution of the problem in the future much more costly and difficult if not effectually block it altogether.

The construction of subways in the congested business section of the city for surface cars will not only prove a failure financially, but fail to give any appreciable relief in any of the essentials of modern transportation, viz., high speed and comfort, close headway, reliability and regularity of service, and uniform schedules.

The highest authorities both in this country and in Europe in discussing the transportation questions for large cities advise strongly against the construction of limited subways for surface cars, and recommend comprehensive, high speed, independent subways as a proper solution for modern urban transportation.

Mr. G. Kemmann, Government Counsellor of Berlin, Germany, in his report on the "Tunnel Projects of the Greater Berlin Street R. R. Co.," says:

"The construction of a number of surface lines into the narrow neck of an underground street railway tunnel is retarding instead of increasing the capacity of a street railway system. The concentration of a number of separate lines, with a certain number of cars of each line into one single tunnel route, will result in overcrowding and resultant dangers due to such conditions, dangers considerably more serious than in surface operation. A reasonably regulated traffic would be almost impossible to obtain with surface cars operated in subways, owing to the irregularity of the service on the surface which will not permit of any systematized dispatch of the cars from and to the stations in the subway."

Mr. E. Biederman, Royal R. R. Building and Traffic Inspector General of the Prussion Railways, Berlin, Germany, in his report on the Transportation Question in the City of Vienna, says:

"Eminent railroad engineers of Vienna have, therefore, come to the conclusion that a tunnel which the street railways of both sides of the city could have to enter, would be no means of rapid

transportation, but, contrary thereto, would develop into a serious hindrance to the former transportation facilities and speed on account of the single tracked, narrow-passed throttles for the approaches of the different car lines into the tunnel. The contraction of the water main, which is fed by several other mains, results in retardation and not accelleration, and causes thereby a reduction of the quantity of water delivered."

The late Harbor and Subway Commission of Chicago, after giving consideration and study to the transportation situation, strongly recommends the construction of independent, high speed subways and against the construction of subways for use of surface cars. In the light of such warnings Chicago is surely not going to make the blunder of constructing a subway that not only will not accomplish any desired results, but will prevent the real solution of the problem for years.

—*John Erickson*

THE RESPONSIBILITY OF DISCRIMINATION*

As men think and act, so run the destinies of those interests in which they have responsibilities. With us in the International, responsibility is centered in a very distinct manner over a wide range of men. Many of us are at the same time employers and employes. From this double standpoint may be realized the increased efficiency of our organization, as a whole, when we not only endeavor, but succeed in serving well those to whom we report, and at the same time ask the same of those who serve and report to us. In speaking of this personal relation between each other, there is implied the highest service to the International, for loyal service from one to another must mean impersonal service.

We stand as men, but we represent the spirit and the activity of the Company. The efficiency of the Company is gauged by the efficiency of the men who operate it in one branch or another. The strength of the personnel, as a whole, is gauged by the strength of each man making up our

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Editor's Note: It would be well for us to remember that that which Mr. McCormick so aptly applies to the International applies also to every institution and corporation.

entire organization. The quality of that personnel is largely determined by the quality of the men in the higher positions of authority, for, with a wave-like motion, appointments pass from one rank to another with unfailing similarity, and the specifications adopted by the leaders are those chosen by others below them, for, unconsciously, we are inclined to appoint or recommend to positions under us men of our own standards. Hence, the need of the leaders to consider well whom they select, who shall in turn, thereafter, select others, and those to select still others as occasion arises. So, at almost any point within the organization roster, one may find himself saying: "As I was selected, so shall I select"—and this gives the double point of contact with those above and those below, and to all thus enumerated comes the question at some time or other—"Whom shall I select?"

An eminent psychologist once said, "The time to lose a job is before you get it; the time to discharge a man is before he is engaged." This means one should not accept a position unless he is quite sure that he can fill it with satisfaction to himself and to his employer; and, secondly, that one should be very careful in choosing a man for a position, and be quite sure that the person he finally has in mind is the best man in sight qualified to try. This, therefore, does not mean a haphazard acceptance or a haphazard choice, but the acceptance of a position and the selection of a candidate should be made with the utmost care and thought, and with a review of the entire field. At best it is a matter of chance, but the risk is susceptible of being reduced to the minimum, and when a mistake is made, if the appointee has failed after a fair trial, the remedy of trying over again is after all the lesser evil, unpleasant and difficult though it may be at the time.

Civil service and the merit system, each splendid in its way, can best be harmonized when careful and intelligent care is exercised in combining the man and the position, and success is much better insured and the field of choice is much broader when the highest possible standards are applied to those first entering service in the originating fields of work, and selection of a man for a position should have reference not only to efficiency in any particular post, but also, and almost equally should

be borne in mind, the individual fitness or promotions naturally falling within his scope as time goes by, thus taking out insurance for the future.

The start into a new position is simply proposition number one; the making good is proposition number two. To the welfare of an institution like the International the problem of selecting men of strength and fitness for positions is infinitely more important than the immediate solution of any given series of problems involving policies, projects or product. The wise solution of these same questions in the future, the avoiding of similar difficulties in the years to come, must depend upon the men we now place "behind the guns." In exercising this discrimination now, we are safeguarding the future. We are dealing with fundamentals. The recognition of this feature of our business, as broad and far reaching as is the influence and activities of the International, constitutes a real Responsibility of Discrimination.

—*Harold F. McCormick*

Representative Dillon, of South Dakota, has introduced a bill in Congress, making the metric system as the sole standard for weights and measures in the United States. The system is to be permissive until July 1, 1920, when it is to be compulsory.

The effect of the passage of the bill, so far as the next five years are concerned, would be to legalize the metric system in all contracts and transactions with the government, but afterward the continued use of the English system would constitute an offense, with regard to which the bill provides as follows:

That any person, corporation, company, society, or association who shall use, or offer and attempt to use, in any industrial or commerciel transaction in the sale or purchase of any commodity any other weights and measures than those of the metric system on and after July 1, 1920, shall be guilty of a misdemeanor, and upon conviction thereof in any court of competent jurisdiction shall be punished by a fine of not more than $500 or by imprisonment for more than three months, or by both such fine and imprisonment.

The result tests the work. —*George Washington.*

Efficient co-operation means elimination of friction and of waste of time and material; in other words, it means that sort of efficiency that today is the slogan in all industry. Modern competition results in large and unnecessary waste and as all waste, as well as the result of every other form of destruction must ultimately be borne by the community at large, such methods must be inimical to the interests of society as a whole.

—*George M. Verity in the Iron Age.*

Of course there may be a natural adaptability for acquiring methods that make for efficiency, and there are certain natural qualities that raise the grade of efficiency: but largely efficiency is a matter of training—of education.

There are several definitions of efficiency. One is accomplishing the most useful results with the least expenditure of energy.

Mere hustle and bustle do not mean efficiency. A man may mark time like a two-minute trotting horse and yet get nowhere. Some men seem to think that if they just work hard enough they must succeed—that hard working means efficiency. They are the ones who accept the maxim that diligence is the mother of good luck.

—*C. J. Norwood in the Colliery Engineer*

ARMOUR INSTITUTE OF TECHNOLOGY BRANCH OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The meeting of the society on December 2, was the third regular meeting. The announcement and details were read from the A. S. M. E. Journal, concerning prizes offered by Henry Hess member of the A. S. M. E., for the best technical papers presented before the Branches by Student Members. This is an added inducement for the students to give talks at meetings.

The speaker was Mr. Frederick Purdy, engineer with the Rayfield Carburetor Co. Mr. Purdy's talk was on "Carburetion." He outlined the development that has taken place along the line of carburetors and used as illustrations working models and slides of different types. An interesting part of the talk was the description of the new Rayfield Carburetor, type G. This carburetor is the very latest thing in that line. Its principal feature is the pressure feed of the gas that takes place when the throttle is opened suddenly.

—*J. A. Agee.*

ARMOUR INSTITUTE OF TECHNOLOGY BRANCH OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

An A. I. E. E. meeting was held on the night of December 3, 1914. The speakers of the evening were J. F. Adamson and H. F. Seeberger. Mr. Seeberger spoke on the operation of the automatic telephone and Mr. Adamson on electricity applied to agriculture. Both papers were very instructive and were enjoyed by a large attendance.

—*C. F. Wright.*

THE CIVIL ENGINEERING SOCIETY

The Civil Engineering Society has met three times since the last issue of the Armour Engineer. On November 10, Prof. Penn delivered a very interesting illustrated talk on the construction of the Panama Canal as he saw it in the summer of 1915. The listeners were well impressed with the magnitude of the engineering feat and the working of the great waterway system as portrayed to them by Mr. Penn's vivid and accurate description.

On November 24, Tenney Ford, '06, now engaged in construction and maintenance of sewage systems in the loop district, addressed the society on the methods used by the city to dispose of the vast amount of sewage. He showed slides of the original plans of the sewage system and went through the steps taken by the city to meet its growth. Mr. Ford also showed some slides of sewers under construction and pointed out the diffiiculties encountered in many cases.

The last meeting, December 14, was of especial interest to students of all departments. Wirt A. Stevens of the class of 1911 and subsequently a mining prospector in the Clear Creek region for three years, was speaker of the evening. As Mr. Stevens expressed it, the meeting was a "talk between the audience and Stevens, Stevens on his feet." The talk was concise, forceful and straight from the shoulder. He told of the very limited opportunities of the small prospector of doing work entirely independent of the large corporations of the mining region which now have the industry by the "nape of the neck." Mr. Stevens has learned that it is impossible to buy lead for smelting purposes and hence it is useless to dig ore assaying at almost any amount. He acquainted the hearers with the works of the promoters and their "cycle." The information was invaluable to the students who are naturally ninety per cent green on the subject. Many of the alumni were present at the meeting.

WESTERN SOCIETY OF ENGINEERS INSPECTION TRIP

On Thursday, January 14, the Junior and Senior Civils and Senior Mechanicals were guests at the annual excursion of the West-

ern Society of Engineers. The students with the bulk of the membership of the society left the Dearborn Street Station at 9:30 A. M. on a special train of seven coaches. It traveled along the Western Indiana tracks and thence on the Belt Line tracks to the new plant of the Crane Comptny. The bare buildings which are just completed and ready for installation of machinery were inspected by the company and the excursion moved on to Clearing where the Belt Line R. R. yards were inspected.

The next place visited was Sears, Roebuck and Company. As it was some time after noon, lunch was partaken of before inspecting the buildings. The luncheon was the courtesy of Sears Roebuck and Company in their mammoth dining room. A splendid repast was enjoyed by all, after which the guests were shown through the buildings in parties of twenty. The visitors were all greatly impressed with the magnitude of the business carried on there and the wonderful system of the business machine.

It was too late in the day to inspect the Soo Line freight terminal as had been anticipated, and so after reaching the Dearborn Station again the company parted until 7:30 P. M.

A Smoker was given by the Western Society of Engineers in the evening. The Armour Glee and Mandolin Clubs sang and played. Mr. G. F. Wheeler was introduced as speaker of the evening. He gave a very instructive lecture on the great American Southwest, the Colorado Canyon, the San Diego and San Francisco Expositions, and the Yellowstone National Park. Lectures on these subjects had doubtless been heard before by most of the audience, but seldom by so illustrious an artist as Mr. Wheeler. The lecture was accompanied with lantern slides and motion pictures. After the lecture, ginger bread and cider were srved. This wound up a most enjoyable day, one that will ever be remembered by the students who received education and enjoyment in abundance through the kindness of the Western Society of Engineers. —*E. R. Marx.*

THE ARMOUR CHEMICAL ENGINEERING SOCIETY

The third meeting of the society was held at the Engineering rooms on November 11th. Professor Freud was the speaker of the evening, and his talk on "New Ideas in Organic Chemistry," met with great favor. From this little talk we learned that chemistry is not as neatly arranged as we think. Most of the great laws find their exceptions when applied to certain organic bodies. However, organic chemistry is a comparitively new subject, and we do not expect to find it on such firm footing as the older sciences. Most of the peculiarities of these bodies are explained in a fashion, and that is the best we can do. Because of the complexity of many of the bodies, we are unable to tell just what the arrangement of the atoms are. Among the oddities we find a compound that has two distinct, but different structures. This, Prof. Freud says, is due to the power of one of the atoms to move about to a certain extent in molecule.

The meeting adjourned after cider and doughnuts had been dispensed with.

The fourth meeting, held on December 9, was one of the few meetings of the year devoted to the ordinary things about which we know so little. Prof. Tibbals spoke on, "The Rare Gases of the Atmosphere." Although we have breathed this mixture of gases all our life, most people know little about the atmosphere in general. The rare gases in the atmosphere are not so rare at all, when we consider that some are present to the extent of one per cent. Prof. Tibbals traced the discovery and history of these gases in a very interesting manner. As he has done some research work along these lines we were able to get a great deal of new data along this line. The meeting was concluded with an interesting discussion from the society members on radium, and we hope to have a more extensive talk on this subject in future lectures. The sophomores have helped to make the meetings a success by the great interest which they have shown at the meetings.

The semi-annual banquet is scheduled for Saturday evening, January 23, at the new Boston Oyster House. Efforts have been made to secure Mr. Chas. C. Kawin, of the Kawin Laboratories

of this city, as the speaker of the evening. We hope that all who can will join to make this one of the best banquets ever held. —*C. C. Congdon.*

THE FIRE PROTECTION ENGINEERING SOCIETY

Since the last issue of THE ARMOUR ENGINEER the Fire Protection Society has held two regular meetings, each one featured by talks given by engineers from the Underwriters laboratories.

The first of these meetings was held in the Engineering rooms, Chapin Hall, on December 3. Mr. Riddle of the Laboratories gave a very interesting and instructive talk on buildings and fire-proof construction. Different types of construction, their advantages and disadvantages were discussed.

The third regular meeting was held on the 7th of January, when Mr. Banash, Assistant Engineer of the Gas and Oils Department of the Underwriters Laboratories gave a talk on the Hazards of Appliances. He discussed and sketched different types of acetylene generators and explained the safety devices employed. He then talked about gasoline garage systems, storage tanks and methods of testing them.

The fourth regular meeting will be held on February 4th. A discussion of "First Aid Extinguishing Apparatus" will be given by Mr. Smith of the Laboratories. By means of these talks the students may become acquainted with the work and methods used in the Laboratories. The society extends a cordial invitation to students of other departments to attend these lectures. They are given on the first Thursday of each month in the Engineering Rooms. —*W. H. Rietz*

THE ATELIER

President ....E. A. Schiffers
Secretary ....C. C. Porter
Treasurer ....Jacob Lewis

On October 9th the Atelier gave a smoker to the Freshmen in the Lunch Room at the Art Institute. Smokes and eats were enjoyed by all. Professor Campbell, our new instructor in design, gave an interesting talk to the old as well as the new students. Mr. Ostergren also made a few remarks at this meeting, a dance was planned for Hallowe'en Eve, but was later postponed until December 4. This dance was held in Blackstone Hall and was a decided success.

On November 25 we received a visit from the Senior Architects of the University of Illinois. They were in Chicago on a three days' inspection trip and took in the Art Institute and the Architectural department of Armour Institute of Technology. After a trip through the Art Institute a turkey dinner was enjoyed in the lunch room. The tenth of December will long be remembered by the Freshmen as the night of "initiation." About twenty-five new members were initiated, after which event a banquet was given to the new men.

The Architectural Department has two new members on the faculty this year. Edmund S. Campbell, who was recently instructor in Carnegie Institute of Technology, and Mr. William H. Lautz, who is a member of the class of 1913. Mr. Campbell is instructor in design and Mr. Lantz has the Freshman class. Mr. Rebori, who was instructor in design for a number of years, has opened up an office in the Michigan Avenue Building. Mr. Alter is in the East.

—*C. C. Porter*

THE ALUMNUS

Being That Part of *The Armour Engineer* Devoted to Personal Mention of the Graduates of the Armour Institute of Technology and to the Affairs of the Armour Alumni Association.

Communications should be addressed to F. G. Heuchling, 1310 Glenlake Ave., Chicago, Ill.

At a recent meeting of the Board of Managers of the Armour Alumni Association a resolution was passed authorizing the appointment of a publication committee, the duty of this committee being to conduct this department of THE ARMOUR ENGINEER. In this manner the work is placed in definite hands and fixes the responsibility for it. Also, the proper opportunity is given to alumni who may wish to make suggestions for the betterment of the department, make criticisms as to its present makeup, or contribute personal items or short articles of interest to alumni.

The co-operation of the Alumni Association with this publication has been mutually beneficial, and it is desired that your co-operation be with both. Your interest will create interest.

THE BANQUET.

The keynote of the mid-winter banquet was "War." Those who entered the Red Room of the La Salle Hotel at 7 o'clock,

December 19, 1914, saw a conspicuous sign bearing the legend, "Nix on the War Talk; This Room is Neutral." With human disregard for signs the assembly disobeyed and would not believe. General Heuchling, Master of Ceremonies pro tem, declared war and mobilization orders were issued. Enlistment followed rapidly and a company of 114 men was formed. News quickly spread through the ranks that the Department of Commissary was making trouble, and outposts reported that the belligerents were putting up a line of defense. Copies of the plans of fortifications were secured by intrepid scouts, and after due deliberation the order to advance was given. Led by General Heuchling and staff the entire company charged in double quick time.

The Department of Commissary evidently had been forewarned, for it was well prepared for such an attack, both as to excellence and abundance of defense, and the unexpected preparedness gave the attacking party a keen relish for the fighting. The battle waged, with outcome uncertain for some time. Whenever the attacking party would lose spirit, "General Electric" Taussig and Cols. Byrne and Flynn would accomplish revival by means of spirited martial songs. It is surmised the battle would have raged all night but for the fact that the ammunition and stores of the Deparment of Commissary became exhausted, forcing the acknowledgment of defeat. The attacking party, with no fatalities reported, was jubilant over the victory, particularly more so over the fruits of the victory. The only marring incident of the engagement was the arrest of Private Clausen, who was court-martialed and sent to the guardhouse. The victory so pleased the General and his staff that orders were given for a general celebration.

The exultant company was somewhat taken aback when it became known that the engagement had been witnessed by an authority on war, Lieut-Col. W. V. Judson, Chief of Engineers, Chicago District, United States Army, a warrior of wide experience gained during many years. However, the Colonel, in commenting on the conflict he had witnessed, had none but words of commendation for the warring engineers. Probably by reason of his experience he had foreseen what was to happen, and so had prepared a timely paper on "Engineering and War." The

interest with which the paper was received was a true mark of the appreciation shown by the company. Through the courtesy of Col. Judson the paper is published in this issue, thus affording those who were unable to hear it an opportunity of reading it in its entirety.

Col. Judson illustrated his talk with a large number of slides, most of them made from photographs secured while he was with the Russian army during the Russo-Japanese war. Explanations and comments on the slides, together with many personal reminiscences made their exhibition of absorbing interest and of educational value as regards the present mode of warfare prevalent in the great European conflict. Col. Judson's contribution to the evening's entertainment was greatly appreciated.

Latest news from the front (at 33rd and Federal streets) was heard from Prof. Phillips. The greeting extended to the boys by the messenger was more cordial than ever, if that were possible. He spoke briefly of the activities at school and of the establishment of a permanent summer camp for civil engineering students on Trout Lake, Wisconsin. A ten-acre tract of land, with a frontage on the lake, has been secured, with rental free, from the Wisconsin Forest Commission, and several buildings have already been erected for the convenience of summer school students.

H. C. Coffeen was called upon for a speech, but was forced, after insistent demand, to begin with a story. He told one, a "Ford" story, so good that everybody "wanted more." However, he turned to serious subjects, commenting on the benefits secured by engineers who hold active membership in professional organizations and alumni associations.

Reports of officers and committees of the Alumni Association were pleasing in their content and their briefness. Stanley Dean read the report of E. F. Hiller, chairman of the Scholarship Loan Fund Committee, the substance of which is printed on a following page. Treasurer Simpson's report was very satisfactory, the figures revealing the fact that, despite the admittedly hard times for the engineer, there were more paid-up members and more cash on hand than at the corresponding time in any previous year; not much, but more.

C. A. Knuepfer, representing The Armour Engineer, made a few well-chosen and forcible remarks emphasizing the desirability of co-operation of alumni and the publication.

Banquet attendance figures show that the class of 1899 again carrie off the high honors, having the largest percentage of members present. In point of numbers the class of 1913 led with 19 men present, the class of 1909 being next with 13 men.

ADDRESSES.

Returns of roster cards sent to all graduates a few weeks before the mid-winter banquet were gratifying, a large majority of the men having devoted the few minutes it takes to fill out the card, thereby keeping the Association informed of their addresses and occupation. Despite the large number of returns, there are still a few men whose addresses are unknown. The list is given below, and anyone knowing the location of any of these men should kindly furnish the information to the Corresponding Secretary, Mr. Stanley Dean, 33rd and Federal Sts., Chicago, Ill.

Salamson, Max ....'97
Naglestock, E. H. ....'98
Persons, V. S. ....'02
Robinson, G. B. ....'03
Harper, R. B. ....'05
Lennartz, G. P. ....'05
Baker, Charles ....'06
Torrance, R. S. ....'06
Lurvey, Dave ....'07
Dowdell, C. O. ....'07
Stanton, Gustav, Jr........'07
Holmboe, Ralph ....'08
Pacyna, Arnold ....'08
Ahern, J. F. ....'09
Urson, F. J., Jr...........'09
Bailey, C. C. ....'10
Gentry, T. E. ....'10
Richards, O. L. ....'10
Bredlau, A. E. ....'11
Hynes, P. H. ....'11
Sears, Ignatius ....'11
Schmidt, Fred ....'12
Meade, G. R. ....'12
Gibbs, A. D. ....'13
Stanley, H. C. ....'13

ANNOUNCEMENT.

This copy of The Armour Engineer is mailed to all members of the Alumni Association who have paid their current dues. It is also mailed to those who have not paid their 1914-15 dues, but have paid their 1913-14 dues. Dues cover the year ending June 1,

but it has been the custom to extend the subscription to this magazine to include the first issue of the following school year. However, no mention was made of this fact in the last issue, and it is for this reason that copies are mailed to some who are in arrears.

It is necessary for the Association to pay for subscriptions in advance thus making it impossible to include upon the list those who have not paid their current dues. Kindly give this matter your attention so you may surely receive the next issue. Send dues to Tracy R. Simpson, Treasurer, 1903 Livingstone Street, Evanston, Ill.

SCHOLARSHIP LOAN FUND NOTES.

We're out of funds again, over a thousand dollars in the fund and all loaned to deserving students.

Hard times seem to have hit Armour graduates as well as others. Only 12 became life members during 1914, compared to 16 during the year before.

We were very willing to accept twenty bones from one H. C. Coffeen who used to make us bone over "descrip" in the period of our freshmanship. If a good insurance man, such as he is now, can perceive the insurance value of a life membership, many others should do likewise.

The class of '02 has increased its life membership by 100% through the addition of two of its graduates to our rolls. They are Roy M. Henderson and William H. Lang whom some of us remember as having added much to the value and friendship of school life in the olden days. The former is down east with the Stone and Webster corporation.

The last life member to join during 1914 was A. L. Eustice. We haven't seen him for many years. We have a lasting impression of him joining a lot of electric lights to some juice and a wheel and making those poor lamps light and relight until they died of exhaustion. It appears from his letterhead that he has profited by this experience as he is now in the light business.

H. L. Strubie was the only addition, since our spring meeting, from the class of '06. This makes the total membership from

that class of 14 or only 9 more than its nearest competitor, the class of 1899.

Somebody ought to be delegated to discover the reason why members of the classes of 1898, 1908, 1910, 1912, 1913 and 1914 have not seen the advantage or have not earned enough money to become life members. The same discoverer should also find out why the large classes of 1905 and 1907 haven't more than 4 life members each.

"Corny," whose right name is J. T. Walbridge, looking from his palatial offices in the Pullman Bldg., over the beautiful waters of Lake Michigan dreamed, on May 23, 1914, of the good that his help would do and sent us a check for $20. Others who desire similar dreams will no doubt be given a chair in his office.

Remember that the committee in charge of the loan fund is composed of E. F. Hiller, 4533 Ellis Ave., Chairman, until May, 1915, Fritz Lindberg, Marquette Bldg., and Stanley Dean at A. I. T. Each will very gladly accept applications for life membership in the association and also applications for loans from students at A. I. T. who need funds in order to complete their education. The funds obtained from life memberships are loaned at 5%, the interest being turned over to the Alumni Association in lieu of the annual dues of $1.00 from each member of the Alumni Association.

Short statement of Loan Fund:

48 life members at $20.00		$ 960.00
1 donation		50.00
Total funds		$1,010.00
Loans made to date	$1,730.00	
Loans repaid	710.00	
Loans outstanding		1,010.00
Funds available for present loans		$0,000.00
Requests for loans now impossible to meet		$150.00

Can we depend upon you, brother alumnus, to aid in raising this $150?

SPECIAL EXTRY

We have just been informed that another check for $50 is on the way from the same generous ex-Armourite who donated that

amount last year. His generosity should be followed by others who are able to spare some of their wealth without great injury. We would like to mention him by name and thank him through these columns, but, at his request, we must refrain from so doing.

—E. F. H.

Those in attendance at the mid-winter banquet found much merriment in the numerous and excellent song sheets provided. There are a few extra copies of one kind, which includes three Armour songs, one being "Armour Y. M. C. A.," and several comic songs. Copies may be secured by sending 25 cents to F. G. Heuchling, 1310 Glenlake Avenue.

ALUMNI NOTES.

1901.

John B. Swift, Jr., has left the Holtzer-Cabot Electric Co. and is now mechanical engineer with the Palmer-Bee Co., Detroit, Mich.

1904.

There is a rumor that E. J. Hiller, the "famous 'cellist," is about to enter the ranks of the benedicts.

1906.

C. C. Hotchkiss, who has been chemist with the Peoples Gas Light & Coke Co. for several years, has severed his connections with that company, and is now in the Department of Public Service, City of Chicago, 613 City Hall.

Tenney S. Ford is now division engineer, Board of Local Improvements, Sewer Division. He has lost his hirsute appendage.

Frank Flanagan is still smiling and doing excellent work as Efficiency Division Expert, City of Chicago, on tasksetting for street cleaning and repair work.

1908.

Isidor Z. Ettenson is spending a few months sojourning in Rosita, Colo.

R. L. Stevens is now in the engineering department, Chicago, Milwaukee & St. Paul Railway, Railway Exchange, Chicago.

1909.

H. C. Frisbie is now employed as engineer with the Cornell Wood Products Co., Cornell, Wis.

Frank H. Mayes is with George W. Hunt, Harris Trust Bldg., Chicago.

F. C. Van Etten, who has been with the Public Service Co., several years, is now Layout Engineer, Department of Gas and Electricity, City Hall, Chicago, Ill.

1910.

A. B. Chapman has accepted a position with the Chicago Telephone Co., 212 W. Washington St., Chicago.

1911.

Tirrell J. Ferrenz has been transferred to the downtown office of the Chicago Surface Lines, 1602 First National Bank Bldg., and is now structural engineer for that company.

J. B. Johnson, formerly concrete designer, Chicago, Milwaukee & St. Paul Railway, is now engineering draftsman, City of Chicago, 2001 City Hall Square Bldg., Chicago.

H. N. Parsons came back to Chicago in time to be one of the joyfuls at the mid-winter banquet of the Alumni Association. He is in the Engineering Department, City of Chicago, 2001 City Hall Square Bldg., Chicago.

C. P. da Silva, who has been in railroad construction work in Pentwater, Mich., is now employed by the Interstate Commerce Commission, Karpen Bldg., Chicago.

1912.

Adolf Hess has left the employ of Sargent & Lundy and is now employed by the City of Chicago, 2001 City Hall Square Bldg.

D. F. Holtman is now structural engineer with the Interstate Commerce Commission, Division of Valuation, Karpen Bldg., Chicago.

P. L. Keachie is now with the Aluminum Castings Co., Detroit, Mich.

One of the classmates of Graham Armstrong received a very interesting letter from him, and below we print some extracts from it. The letter was written in Brakpan, Transvaal, So. Africa, and was dated Sept. 27, 1914. He writes:

"Your very welcome letter reached me safely. I was glad to hear from you—more so because it was the first from Chicago. You will see by the above address where I am located, but I want you to send any letters to my home address, as I do not intend staying at such a God-forsaken place as this is. Everything in general is in such a bad way in Bloemfontein, due to the war, I could not get anything to do there. I had an offer from the Victoria Falls & Transvaal Power Co. to become an assistant operator and accepted it. For three weeks I was located in Johannesburg, at the Rosherville plant. Now they have shipped me out to this place as a senior operator. My dislike for operating as as strong as ever and especially now that I am located out in the wilds. There is nothing here except the plant and the company's quarters—we are 21 miles from Johannesburg. The quarters are miserably dilapidated, with no conveniences whatever. You have to furnish your own room with everything. There is a boarding house here—the food is not so bad—but we mingle with a very mixed crowd, anything from the engineer-in-charge down to the oilers. You can imagine how I miss my comfortable room in Chicago with the running water; that was a prince's life compared to this. There is every evidence that some one has had some good hunting here at night; so far I have not had any trouble. I have a couple of applications in with some engineers and hope to get something more congenial as soon as the war is ended.

"We have German territory adjacent which has been giving trouble. Thousands of local troops have been sent to quiet matters. We do not anticipate any trouble from the natives, but there might be some from the Boers, who are in sympathy with the Germans. You may know what the feeling is when our General Beyers resigned his commandership of the South African forces. Needless to say, he is a Dutchman. His reason for resigning was that he does not approve of sending forces over the German borders. General Botha, the premier, has taken command.

"I am glad to be back in sunny South Africa. You cannot imagine what a lovely climate we have—sunshine nearly all the year round. At present the country is suffering from a seven years' drought. The rainfall all comes at once and runs off the

ground before it has much time to do any good. It is surprising to see how things will grow where there is apparently no moisture. Of course there is plenty of dust this time of year, especially near the mines. There they have great mounds of earth about a hundred feet high and a mile around the base—all this is dug out of the mines. This finely pulverized earth just blows off in great clouds. There is no other mining but for gold in Johannesburg, the diamond mines being in Kimberley and Pretoria. While the war is on no gold is being shipped out of the country, but is being deposited in banks and guarded by armed police."

A later communication from "Army" states that he and his fellow workers are all under military training, and that indications point to more war.

1913.

Howard Cooper is now located in St. Louis, Mo., where he is employed as lubricating engineer, 2414 De Kalb St. He made the trip from St. Louis to attend the mid-winter banquet of the Alumni Association.

Ralph W. Ermling has returned from Paris, France, where he attended Ecole des Beaux Arts, and is now pursuing his profession as architect, 1529 Michigan Boulevard Bldg., Chicago, Ill.

John J. Fieldseth is assistant county engineer, Armstrong, Ia.

G. F. Irving is superintendent of building construction, Winnipeg, Manitoba.

John L. Stewart, formerly with the Pullman Car Co., is now in the engineering department, Illinois Central Railroad, Chicago.

W. H. Yorke is now employed by the Petersen Oven Co., 112 W. Adams St., Chicago.

1914.

John R. Charlton, who was in the Engineering Department of the Chicago Telephone Co., is now instructor in manual training at Le Roy, Ill.

F. Isensee is employed in Terre Haute, Ind., his business address being 311 Terre Haute Trust Bldg.

L. C. Meyer is with the W. A. Jones Foundry & Machine Co., 1401 W. North Ave., Chicago.

H. Perlstein has accepted a position with the Standard Alcohol Co., Fullerton, La.

Walter H. Hallstein is employed as investigator, Efficiency Bureau, City of Chicago, City Hall.

C. C. Heritage is chief chemist, the Nehassa Edward Paper Co., Port Edwards, Wis.

E. L. Nelson is working on electrical equipment for railway cars for the Pullman Co., Chicago.

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(Signed) AL. N. GROSSMAN,
Business Manager.

Sworn to and subscribed before me this 30th day of January, 1915.

[Notary Seal] JULIA BEVERIDGE,
Notary Public.

My commission expires Jan. 8th, 1918.

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VOLUME VII. MARCH, 1915 NUMBER III.

CITY PAVEMENT MAINTENANCE AND REPAIR WORK IN CHICAGO

BY W. G. LEININGER*

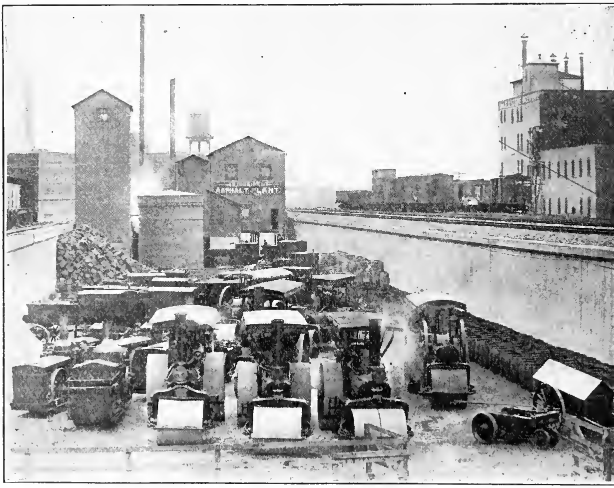
THE MUNICIPAL ASPHALT PLANT OF THE CITY OF CHICAGO

In all cities where repair work is done by contract, the sum of money expended is large in proportion to the yardage repaired, and in order to get repairs done quickly by this method, a great deal of time is expended in notifying the contractor and estimating and finally settling on the work actually done. The City must keep all records of yardage, cost, etc., just as completely as if they were doing the work themselves. Hence, when the Bureau of Streets decided to do their own asphalt repair work, it was necessary only to add a field force to the men already engaged in this work. The first year that any attempt was made to repair by day labor, all material was purchased at the plant of a contractor. The hauling and placing was carried on by the Street Department. Chemical tests were made of all material purchased, and although the mix and material was good, the Bureau had no opportunity to try a new method mix or material where they felt the same might give better results. It was the necessity of a plant for this purpose, and the cheaper manufacture, that resulted in the building of the present Municipal Asphalt Plant of the City of Chicago.

The next problem that confronted the Department was the location. It should be centrally located to the area of asphalt streets or contemplated asphalt streets. The location chosen was first considered by many as unfit for such an undertaking—15th Place between Loomis Street and Ashland Avenue is 66 feet

*Class of 1906. Superintendent of Streets, City of Chicago.

wide and is bounded on both north and south by elevated steam railroads. The walls supporting these tracks are 17 feet in height and afford an ideal side track where material can be unloaded into bins along the wall, or lowered in the elevator constructed for this purpose.



Asphalt Plant Looking West. Road Equipment Repaired and Ready For Use.

The plant proper was constructed by Hetherington and Berner, at a cost of $46,000.00.

The Department then took up the matter of an additional building to be used as office, scale house, chemical laboratory and baths. In addition to the first sum, the plant today represents approximately an expenditure of $75,000.00.

The plant can be utilized for the manufacture of top, binder or bituminous mixtures, and has a rated capacity of 2,000 yards of finished pavement per day of eight hours. By finished pavement is meant two inches of top and two inches of binder.

The plant is run on a different basis from other cities. A credit of $75,000.00 was placed at the disposal of the plant, the same to be known as a capital account. This amount gave the plant the required money with which to purchase supplies and material for the year's work. Each of the thirty-five wards in the city is credited with a certain per cent of the Vehicle Tax Fund based on the amount of collection in that particular ward. Hence when the Plant is furnishing material for any ward, it is charged for at a standard price per ton; this price is sufficient to allow for all overhead expenses plus depreciation. It is interesting to know that these prices are much lower than could be procured by contract. The charge for top mixture is $7.50 per ton, for binder $4.50 per ton and for bituminous macadam $5.00 per ton. The actual cost to the plant for top is $5.75, for binder $3.75 per ton and for bituminous macadam $4.00 per ton. Hence, during the operation of the plant an earning of $4,000.00 average per month will be shown. This earning holds the capital account stable and allows for all depreciation, repairs and the like.

The asphalt repair division is under direct supervision of a General Foreman of Asphalt Repairs who reports directly to the Superintendent of Streets. In this way rapid operation and decision is acquired.

Upon entering the plant from Ashland Avenue at the right is the office of the Plant foreman, above which is the chemical laboratory. Just behind the office is a long storage room where parts and tools for all kinds of asphalt works are held in reserve. The next building to the right is the office of the scaleman, where all material is weighed as it leaves the plant. Just behind this office is the locker room and shower baths. Here the men dress and wash and at the close of the day's work leave the plant refreshed and clean.

All apparatus in and about the plant is of the latest and best type. The chemical laboratory is in charge of a chemist and his assistant who employ two samplers. The laboratory is light and airy, well ventilated and fitted with hoods in which all gases are carried off. All testing apparatus is of the best, and arranged in the most efficient manner. All materials used in connection with the plant and the work are tested by standard methods to

insure the best results and to obtain a good compliance with the Bureau's specifications. A copy of all tests is placed on file in the Bureau, and a duplicate is retained at the Plant. In this way all department heads, inspectors, etc., are kept in touch with the class of material being used. All requisitions for material bear the signature of the chemist, showing that the material is correct in all respects. Not only raw material but the mixtures made for repair are tested from time to time, so that at any time the mixture used on any job can be ascertained and the results of wear noted. All entrances to the Plant are paved with granite block and all portions kept in excellent condition by the watchmen. A sewer directly through the street takes care of all drainage of roadways and pits. All storage tanks are placed underground where practical, and encased in concrete. The Plant is electrically operated and lighted so that it can operate at night if necessary. This current is furnished by contract from the Sanitary District of Chicago at the regular rate for plants of this nature. The force which has been found necessary in order to operate includes:

1 Foreman of Asphalt Plant
1 Foreman of Drum men
2 Drum men
3 Kettle men
1 Mixer man
15 Laborers
1 Chemist
1 Asst. Chemist
2 Samplers
2 Watchmen

The street repair gangs which range from two to five in number, depending upon the amount of work and the period of the year, are composed of the following:

1 Foreman of asphalt repairs
1 Foreman of cut outs
3 Rakers
3 Smoothers
3 Tampers
30 Helpers
1 Rollerman
2 Watchmen

With each gang are sufficient teams to keep material constantly at hand and remove old top. The hauling of material will be greatly improved and cheapened in the near future for the Bureau has purchased two five-ton Pierce Arrow Dump Trucks to assist in the long hauls. It is estimated that each truck will take the place of 3½ teams on this work.

The first attempt by the Bureau in 1912 to repair streets out of reserve was done by contracting for material at the plant of a contractor by the ton. Hauling and laying was done by the city's forces and although the cost of material was high, the results were pleasing and the work was of a high standard. This high standard is showing more and more each year by the decrease in the yardage to be repaired on streets where careful work was done.

In the first year's work the following will give an idea of the saving even by the purchase of a contract mixture.

Out of reserve and maintained in 1912, 2,059,000 sq. yds. asphalt

Total yards repaired	76,488
Total cost of repairs	$105,160.52
Average cost per square yard	1.375
Average cost of maintenance per square yard	.051

Previous to this time all repair was done by contract, and a fair average of maintenance cost was about $.06 per square yard.

The first years' operation with the plant was done in 1913 and the results are exceedingly encouraging, since the plant force was being broken in and the new machinery worked hard, as is usual with a new plant of this size. The system of getting material, unloading and storing the same in convenient places was also a new proposition, and the storage bins were not then completed. Nevertheless, considering all the drawbacks to the opening and operation of a new plant, the following results speak for themselves:

Out of reserve in 1913 ......4,309,200 sq. yds. asphalt	
Maintained by the Bureau in 1913........	3,547,600
Total yards repaired	147,638
Total cost of repairs	$119,828.63
Average cost of repair per square yard....	.8116
Average cost of maintenance per square yard	.0338

We are looking forward to another decrease in the work of the present year. Just what the cost will be cannot now be estimated, since the quantity is large and the Bureau has been reaching out in other lines.

The proposed repair work for the year is laid out on a small map by the General Foreman in charge. Care is taken to district this work in a manner that will require the shortest moves and a system of streets is repaired in one location before moving on to the next. The first move made upon the arrival of the gang upon a street is to mark out the cuts to be made and holes to be repaired. This is done by the Foreman of Cutouts, and passed upon by the General Foreman. As fast as the cuts are made and trimmed, the old material is gathered up and taken away. The painting of the edges is next completed by using Asphaltic Cement. The binder gang then follows up, bringing up the repair to within an inch and a half to two inches of the top. The binder is tamped and smoothed, ready for the top. The top is then laid, raked, smoothed and ironed; after rolling with a five or eight ton roller the top is dusted with cement and barricaded with wooden horses until ready for opening the street to traffic.

Record of all asphalt streets in the city, as well as those of other materials is kept by map and card index. All streets under the contractors' reserve are placed on the map under a distinct color in dotted line, and as soon as these streets fall to the city to maintain, the line is made solid. All dimensions, data, etc., pertaining to this street are filed alphabetically in a card index file and on the reverse side a complete record of repair is kept, showing yardage repaired, cost, etc. In order that the Superintendent of Streets may keep in constant touch with the various repair gangs, a map with colored thumb tacks showing the location of each gang is kept. A location report is sent to the office of the Bureau each night, by the various foremen, and the plat is kept to date in this way. The location of road rollers is noted by the same method and in this way the shortest moves for the machines can be planned by the Assistant Superintendent in charge of repairs. Each roller bears a number. The duplicate of this number appears on the location map.

The total capacity of the storage bins is approximately 860

cubic yards of sand and stone. The cement is kept in a brick lined room, air and water tight. Five hundred barrels of cement are kept in readiness for use at all times.

From the storage bins the material is carried by conveyors to the hoppers located at the top of the plant. From these hoppers it is fed to the different mixers as required. After mixing it is conveyed to the wagons and arrives on the job at from 280 to 320 degrees F.

Each wagon is loaded in approximately ten minutes, and top and binder can be loaded at the same time, there being two mixers. Besides the manufacture of top and binder, the plant turns out all asphaltic filler required for brick and granite block repair. The liquid asphalt used for building macadam streets by the penetration method is also made at the Asphalt Plant. The plant is at present using the following brands of asphalt:

Trinidad Lake natural asphalt,

Cuban,

And different brands of blown oil product.

The department this year purchased twenty-three one-yard asphalt wagons. When other wagons are needed they are hired by the day. The city owns no horses. The largest number of asphalt wagons working this year was sixty, and this number varies from time to time a great deal, depending on the length of haul.

In the beginning, naturally all eyes were focused on Chicago in this undertaking and co-operation was not asked nor expected from outside concerns interested in the asphalt work. The success of the undertaking is based on hearty co-operation of the citys' forces and the interest displayed by the competent men in charge. The best material linked with care and pains in laying the same have insured the best results. The experiments carried on from time to time on new mixtures and the action under traffic carefully noted gives the men in this work the ability of quick decision and choice on streets coming up for repair. At the present time the resurfacing of old granite block and brick pavement is being carefully watched. These results will be known in a year or so. Each year more and more asphalt pavement besides that of other materials runs out of the contractor's reserve period, and falls to the Bureau of Streets for maintenance. Naturally, it is to be expected that the present plant and

equipment will be inadequate to supply the wants, and in the future an additional plant of size and capacity necessary will be required. This plant will be located at a central point to the increased area. So far it has not been necessary to run the plant at the maximum capacity and we are not positive of the overload it is capable of caring for. It is also a fact that with a few slight changes or additions the present capacity of the plant can be greatly increased. The appearance in and about an asphalt plant is in most instances not pleasing. It is naturally a dirty, smoky place. It is with this in mind that the City of Chicago invites the visit of interested people and we can safely say that they will go away with the impression that cleanliness and beauty have been a factor carefully watched in the construction and operation of the *Municipal Asphalt Plant of Chicago.*

ASPHALT REPAIR BY BUREAU OF STREETS, CITY OF CHICAGO

The entire Asphalt Repair Division is under the supervision of Thomas L. Dooley, General Foreman of the Asphalt repairs, whose extensive experience in the Asphalt business makes him an efficient man in this division. The General Foreman reports directly to the Superintendent of Streets, which gives this division the advantage of quick operation.

This year the Bureau of Streets purchased from Warren Brothers a one-car railroad plant. This plant can be moved around on the outskirts of the city where it is proposed to resurface the macadam roads with a bituminous top. It is practically impossible to do this work from the stationary plant since the long haul would run the cost up to an impossible figure. This railroad plant has a capacity of two thousand square yards of two-inch top per day of eight hours. It is expected that the force required to operate this plant will consist of:

1 foreman	1 mixer man
2 drum men	1 engineer
2 kettle men	15 laborers

2 watchmen

The Bureau is considering the use of two five-ton auto trucks to handle the material from this plant to the job. All material to be used will be received on track beside the plant and can be used as required.

Specifications are now on file for a Portable Plant to utilize old Asphalt top. In all repair work considerable old asphalt is cut out and this must be disposed of. It is rather bulky and is not acceptable for filling where there is traffic, such as alleys and unpaved streets. Hence the disposal of this material and finding a suitable dumping ground is a large factor in the cost of repair. It is the intention to locate this plant in some central place where it will be accessible to the street gangs for several months. Old material can then be carried to this plant, crushed and re-heated with new material and taken back to the job to be used as binder. In this way the expense of long haul and the waste of old material can be cut down. The capacity of this plant will be ten tons of top per hour, using sand containing 5% of moisture. This plant can be moved by teams, roller or traction engine, and will have a clear head room of about twelve feet.

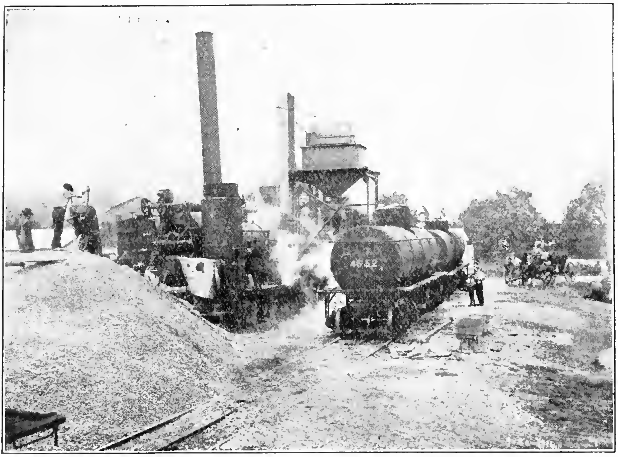
The first year's operation was carried on before the completion of the Municipal Plant, hence the material was purchased by contract and laid by the gangs from the *Street Department*. The showing is necessarily higher, due to the high price of material, as is shown on page 177.

The year before this repair work was done by contract and the price bid was exceedingly low. Nevertheless, the average cost of maintenance by contract was $.057.

The first year's operation with the plant was done in 1913 and the results are exceedingly encouraging since the plant forces were being broken in and the new machinery worked a little hard, as is usual with new plants. The results given on pages 177 show this clearly.

The work done by the Bureau is of the highest grade. The best material is used and the greatest care and pains are used to insure the best results. Experiments are made from time to time on new mixtures and their action under traffic are carefully studied. At present the re-surfacing of old granite block

and brick pavement is being carefully watched and the results will be well known in another year or so. Each year more and more asphalt pavement runs out of the contractor's reserve and falls to this Bureau to maintain. It is expected that in time the amount to be maintained will reach such a quantity that the present equipment will be inadequate and an additional plant will be required, located at some point central to the increased area.



The Railroad Plant.

At the present time the plant has not been running at its maximum capacity and we are not positive of the overload it will manage. There is also a chance that the capacity of the present plant could be greatly increased by slight additions to the present apparatus. To cut own the large amount of money expended each year on Macadam Road Repair, the Superintendent of Streets has advised the re-surfacing of the roads connecting outlying suburbs with a two-inch top of bituminous nature. These roads will require re-shaping and the cost of repair by this method and the addition of asphaltic top should cost about $.80

per square yard. The present condition of the roads and the length of haul will be the greatest factor in determining this cost; but the ultimate maintenance will be greatly reduced and the conditions of the roads will be greatly improved.

Macadam Roads

In the last five years the traffic from outlying suburbs has increased so rapidly that the demand for good roads to Chicago's paved streets had to be considered. In past years at certain periods of the season these connecting roads were in such bad condition that the outlying suburbs were actually cut off from vehicle traffic, to say nothing of the immense auto traffic.

It was due to this, and the movement on foot for good roads throughout the States that a plan for connecting links was consumated. Such a plan is enclosed in this report. Practically the only pavement which could be considered in this plan was one of cheapness and one which could rapidly be constructed with no great amount of previous preparation.

For years past the Bureau of Streets has carried on macadam road building, hence the organization was in working order. Each gang consists of approximately 18 men, 2 foremen, 15 to 20 teams, 1-12 ton steam roller, 1 sprinkling cart and 1 road grader; 14 men are kept on cars unloading stone while the remainder spread the same and carry on the necessary work in connection with construction. The organization for construction is the same used for maintenance, and since this maintenance can only be carried on in the Spring and Summer, these men are the maintenance as well as the construction force.

The character of road construction consist in first preparing the subgrade. This can either be done by hand, but in most instances the material permits of the use of a road grader. This grader is set to cut four or five inches at the edge, dragging all material to the center and in most instances the center can stand the extra fill. All holes and ruts are filled up and the subgrade rolled. Upon this subgrade six inches of large stone is laid. This stone will measure four to six inches in diameter. The stone is then rolled to more nearly close up the voids and drive the stone into the subgrade for a solid hold.

Upon this, 3 to 4 inches of medium stone is placed. This

stone will measure 1½ to 2 inches in diameter. This layer is roughly spread with limestone screenings, watered and rolled to insure filling the voids. Then the road is well screened and care taken to roll while wet. The rolling is continued until the surface flushes. When this occurs, the surface is swept to insure filling all voids and the road is barricaded for 4 or 5 days. At the end of this time the roller is again put on the street and the surface ironed to insure smoothness. The finished road will measure 18 feet wide, 10″ deep at the center and 6″ at the edges. The crown is from 6″ to 8″ above the edges.

The requisite for a good road is mainly drainage of both subsoil and surface. Hence the shoulder or berm must not be too high, but should slope towards the ditches with practically the same slope as the pavement.

In most cases the ditches are 3 or 4 feet below the crown and should be kept clean and kept at this depth below the street. To save expense the line and grade are made to conform to the old road and in no instance have these conditions interferred with traffic. Where bad subsoil is found and rolling cannot be done, the large stone is put in and screened. Rolling is done where possible and the street left to set. The following year this can be finished for a good foundation is in place. On all incoming streets an apron is built, 10 to 12″ in length, running from 4″ to zero. This protects the edge of pavement from incoming traffic. In 1912, 83,236 yards of macadam road were built, at an average cost of .56c per yard. At the end of 1912, a total of 55 miles had been completed. Although water bound macadam seems to be the only cheap pavement for outlying roads, it is not advised for city streets for the dust nuisance is a great source of complaint. The only cheap repair that can be made is to oil and cover with sand, ½″ limestone screenings, or granite chips. Heavy oil is more satisfactory where great care is taken to apply hot and immediately cover with screenings. The complaint which follows is due to the fact that heavy oil penetrates slowly and is tracked by pedestrians into houses and upon sidewalks. In 1912, 5,311,144 square yards were oiled at a cost of $.0135 per yard. In all 1,353,753 gallons were used. Repairs can be made in the following manner: Where the road has a fair thickness the same can be scarified and additional stone be

placed, the same construction being used as on new work. Where it is advisable to lay three inches or more of stone no scarifying is found necessary.

Where the pavement is in fair condition except for an occasional hole or rut, the same can be repaired by cutting out the hole, placing stone and covering the same with asphaltic cement or tar. About 1½ gallons to the yard is found to be efficient.

Finished Macadam Road.

Undoubtedly the best method is to place the roads under the "Patrol System." In this way one man has a district or strip to care for. He is furnished with necessary tools and material, including a tar heater. His duties being confined to the maintenance of roads in his district. Care must be exercised in cutting out holes for without proper edges the repair will not last. Merely filling a rut or hole does not insure a permanent repair.

The department is now considering automobile trucks of 5 Ton Type for spreading oil on macadam streets. It is felt that one machine will take the place of 3 horse drawn spreaders and

cover the ground in a more efficient manner, to say nothing of the advantage of speed. The manner of hauling crushed stone is also being considered, and 2-5 Ton trucks will be put into service this season if possible. It has also been advised, in order to maintain quick repairs in the case of emergency, that a 2 ton auto truck be installed. This truck will be operated by the head chauffeur and his duty will consist in keeping all apparatus in working order, and supplying repair parts with the least delay. Bids are now being considered for seven 5 ton automobile flushers and oilers, two 5 ton auto truck dumps, and one 2 ton auto truck express. The main object of the Bureau of Streets is to enforce steady and uninterrupted service in all branches, cutting all delays to a minimum.

Brick

The Bureau had out of reserve December 31, 1914, 1,083,300 square yards of brick pavement, which falls to their lot to keep in good repair. Out of this amount 1,029,000 square yards were maintained.

Total yards repaired	58,284 sq. yds.
Total cost of repair	$58,169.52
Average cost per sq. yd.	.998
Average cost per sq. yd. maintenance	.0565

The work was done by our own forces and the cost of this work the previous year was $1.31 per sq. yd., average cost of maintenance being $.066. Old brick is hard to maintain, due to the fact that the brick wears down, and the new block being of greater size the surface is not uniform, hence the cost of repair is necessarily high. We are now considering the repair of brick which is in extra bad condition with a 2-inch top of sheet asphalt. In the case of subways, the department is in favor of the substitution of granite block for brick.

Granite

In the repair of granite block it might be interesting to note that the cost in 1912 was $.732 per square yard, which is considerable under the brick cost. Granite can be cleaned and relayed with the best side up to traffic and in addition, it is slow to wear. In some cases where the blocks are badly worn new block must be used. The filler found to give the best results is

pitch. On bridge approaches and heavy grades these blocks become slippery and we are now considering the use of a hard sand stone, one which will reduce the slippery condition, and one which will wear well. At present we are experimenting with block of this type, and feel that in time a suitable material will be found.

CHICAGO'S PORTABLE ASPHALT PLANT and THE RESURFACING OF MACADAM ROADS

Through the efforts of Mayor Harrison, the Highway Improvement Association and the Association of Commerce co-operating, in 1913 an appropriation for street repair equipment was secured and machinery installed that marked the inauguration of increased efficiency in street repairs chargeable to the *Wheel Tax.*

At the close of the year the Bureau had complied with the earnest demands of the outlying districts and suburbs by completing a series of connecting links from these localities to the City's paved streets. Previous to this time some of these districts were entirely shut off for a considerable time on account of impassable roads. These roads were naturally constructed of water bound macadam and oiled. Naturally, macadam seems to be the answer when the first improvement is considered, and although very little can be said in favor of it when subjected to heavy traffic, it is the foundation for the future good road.

The price is the first consideration, but the maintenance has cut such a noticeable figure that further consideration must be given the subject. When the maintenance runs up to 20c per sq. yd. it is appalling to think that in five years the original cost of the pavement has been duplicated. When ditching, grading, laying and properly constructing the shoulder is completed a dollar a square yard is cheap, and yet the Bureau of Streets constructed 83,000 square yards, at a cost of 56c per square yard.

Why does this pavement fail? has been asked many times, and the answer has always been—low, wet land, and the tendency for traffic to keep in the same rut on an 18 foot road. To eliminate this it was decided to cut down the crown and re-surface

these roads as fast as possible with a two-inch top of asphaltic concrete. The present asphalt plant was located to take care of asphalt repairs on the city's streets out of reserve; hence the necessity for a portable plant was imperative. Such an equipment in the shape of a one-car portable plant, equipped to burn coal or oil, was purchased from Warren Brothers, at a cost of $13,000.00.

This plant can be moved about at the outskirts of the city and the re-surfacing of old macadam country roads has now begun in earnest. The plant has been turning out 2,500 sq. yds. of two-inch top per day. The Bureau is completing a mile of 18 foot road each week and the cost per sq. yd. is approximately 75c. This includes all cost of preparing the old road and laying the two-inch top. Such an improvement will last five years without repair, and the maintenance will then be slight in comparison to the old water bound macadam. It is desirable to have at least ten inches of stone at the center and from four to six inches at the edges, hence in some cases, three to four inches of new material is laid on the road before re-surfacing. The surface is made as flat as possible, and since Chicago is naturally flat, there are no noticeable grades. The old macadam roads were constructed with as little grading to profile as could be accomplished, hence the finished re-surfacing is practically at the same profile. An absolute profile would necessarily be followed in a rough and uneven locality which would increase the cost considerable.

When it is considered that the department has repaired 300 miles of macadam pavement this year and re-surfaced five miles of it with asphaltic concrete, the great amount of work ahead seems appalling. The success of this improvement is hinged entirely upon the wheel-tax collections, which up to date represent $650,000.00. Out of this the department has spent for all repairs $450,000.00.

The present plant can re-surface 30 miles in a season without trouble, and with the proper funds and equipment the 500 miles of macadam streets in Chicago would soon be made permanent pavements. An earnest endeavor along this line should be followed, for then the cost per lineal foot to the property would not exceed $1.25 on each side of the street. When this price is

compared with the assessment usual for a permanent pavement the re-surfacing plan should be met with approval by the property owners and parties interested in *good roads.*

Every interest is directed to the proper and scientific methods of doing this work and in obtaining the best results. The mix so far will average approximately

6.5% bitumen,
37.2% sand,
52.3% stone,
4.0% filler.

The aggregate being used in crushed granite ranging from 1/4 inch to 1 inch in diameter, with torpedo sand and portland cement. The price of granite this year is $2.25 per cubic yard. The plant is located on a center track, with two switch tracks, one on each side thereof, and 16 feet distant. Material is placed on these tracks and unloaded directly in front of the different conveyors. The sand and stone are mixed in proper proportions and run into the dryer where it is heated to 300 degrees F. From there it is conveyed to the storage bins and thence to the measuring bins, where it is drawn off to the 15 cubic foot mixer as required.

To facilitate the quick delivery of material on track, the Bureau has a car tracer who covers the territory on a motorcycle and keeps the cars in transit. This man covers a distance of 75 miles each day.

The work of preparing the old macadam road differs somewhat in different localities. Where the existing surface is in good condition and has a suitable line grade and contour, the surface is swept thoroughly to remove all the loose particles and expose the rough stone. If any depressions exist they are filled with binder and tamped; in this way the existing road is made parallel to and two inches below the finished surface. Along the edges of the road care is taken to provide a good shoulder to hold the pavement in place. Where the soil is soft, stone is added and the shoulder thoroughly rolled.

Where the old macadam is flat or depressed at the center the sides are picked up and the material moved to the center. Care is taken not to lower the sides so that less than four inches of stone exists in a firm condition.

Where the condition is such that additional material is required, the street is scarified to a depth of three inches, and material added, making the center at least ten inches in depth and the sides six inches. About 2½ inches is found sufficient for drainage from the crown to the edge. At the present time the plant is running at capacity, and the force at the plant and on the street consist of:

Plant.

1 foreman asphalt plant
1 chief drum man
1 drum man
1 kettle man
1 mixer man
2 time keepers and material men
25 laborers
18 teams
1 assistant chemist
2 watchmen.

Field.

1 asphalt foreman
2 rakers
2 smoothers
2 tampers
15 helpers
2 watchmen
2 roller engineers.

In order to hold the present macadam streets in place until they can be re-surfaced at some future time, the Bureau has used 1,720,000 gallons of heavy road oil. This oil helps to bind the macadam and stops the dust nuisance. Road oil was purchased this year for approximately $0.0364 per gallon.

On July 30, the Bureau of Streets, in conjunction with the Association of Good Roads, took interested citizens, contractors, automobile manufacturers, and City officials through the shops and plants of the Bureau and over the streets and roads being repaired by the department. This was the first trip of the kind that any of these men had taken, and the result was encouraging for it developed a sentiment and interest in the Bureau's endeavors that could not be gained in any other way. It demonstrated

that the wheel tax fund was being spent judiciously and that the work was being pursued in a scientific and efficient manner; it also created an interest in the collection of more wheel tax money and the necessity of additional appropriations to help out along the lines of a great improvement. This year's work has completed all but half a mile of a through route from Chicago to the Lincoln Highway, which with the interest now at its height, may be improved before the close of the season.

PHYSICAL INTERPRETATION OF THERMODYNAMIC PRINCIPLES†

BY J. M. SPITZGLASS*

The first law of Thermodynamics is a statement of a fact, established by experiment, that heat and mechanical energy are mutually convertible, and that a unit of heat is an exact equivalent to a number of work units, which was determined by Joule to be 778 foot pounds for each B. T. U. This may be shown by the equation

$$W = JH$$

W = work in foot pounds.
H = heat in B. T. U.
$J = 778.$

Sometimes it is stated in another way; we say,

$$AW = H$$

Then, $A = 1/J = 1/778$

The second law of Thermodynamics is not an experimental fact, but is a statement deduced analytically from the principle of conservation of energy that heat can be transferred into work only when passing from a higher to a lower temperature. That is, if the rectangle a-b-e-f (Fig. 1) is made to represent the total heat in B. T. U. contained in a given source at a temperature T_1 and with heat units per degree, ϕ_1, and if the temperature of the source can be reduced only to a lower temperature T_2, then the maximum amount of heat that can be transposed into work is the area a-b-c-d, while the balance represented by the area c-d-e-f, has to be rejected or wasted as far as its utilization for work is concerned.

Now, work can easily be changed into heat without loss even in practice, but heat never can be entirely changed into work except in theory, and it is the object of thermodynamics to determine the laws governing this change of heat into work and the behaviour of the heat carriers or substances utilized to perform the

†Lecture Delivered before the Senior Mechanical Engineering Class at Armour Institute of Technogoly, January 26, 1915.

*Class of 1909. With the Peoples Gas Light and Coke Company.

transportation of heat into work. Thermodynamics concerns itsself first with the behaviour of what we call perfect gases because they strictly follow general laws when undergoing certain physical changes. I propose to consider these general laws from a novel standpoint.

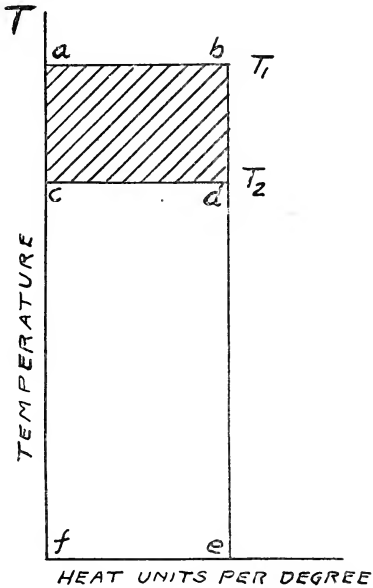


Fig. 1.

Consider a unit weight of gas, say one pound, confined in a vessel (see Fig. 2) and closed by a smooth, frictionless plug. Now, this pound of gas can undergo an unlimited number of changes with regard to its volume, pressure and temperature and still be the same pound by weight. Therefore we are justified in saying that in order to know what the pound of gas represents, or in order to have a complete picture of the quantity of gas confined in the vessel, we have to know the volume, the pressure

and the temperature. Let the volume of the gas be V cubic feet; let the pressure inside the vessel be P pounds per square foot, and let the temperature be t degrees F., then V. P and t determine the state or condition of the gas confined in the vessel. It was always known, even before people had any idea about thermodynamics, that the state of a gas is not definitely known until these three quantities are given. Thermodynamics goes into the

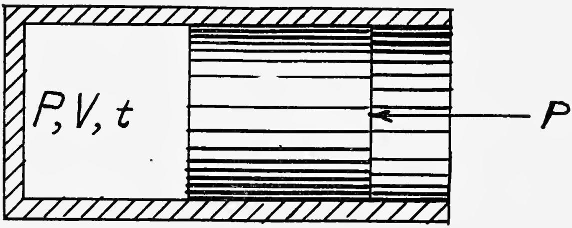


Fig. 2.

details of establishing the natural relation between these quantities mathematically. These relations were determined step by step, and not always from the same direction, which makes the subject somewhat complicated if the steps are not followed in the right order. It was determined experimentally by Charles and by Gay-Lussac, that when a unit weight of gas is free to expand under the application of heat, each additional degree of temperature increases the volume of the gas by exactly the same amount, and this increase for each degree is equal to 1/460 of the volume that the same unit weight occupied at zero degrees F. The physical change that takes place with this increase in temperature is increased by one degree F, the volume expands until with Fig. 2. As the pressure remains constant while the temperature is increased one degree Fah. the volume expands until it is increased by an amount equal to 1/460 of the volume at zero degrees.

The algebraic expression of this relation is

$$V = V_0 + \frac{V_0 t}{460} = V_0 \left(1 + \frac{t}{460}\right)$$

That is, the increase in volume for one degree at any temperature, t, is $\frac{V_0}{460}$ cubic feet.

Where V is the volume of the gas at any temperature t, and V_0 is the volume of the same gas at zero F.

It was desired to make this expression more general, so as to

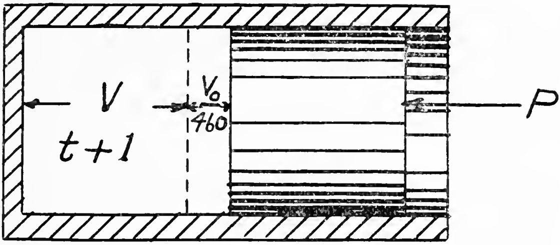


Fig. 3.

refer to any temperature and it was done in the following way.

In Fig. 4, let OX represent temperatures measured in degrees F, and OY the corresponding volumes of a unit weight of gas; let V_0, V_1, V_2 be the volumes corresponding to the temperatures t_0, t_1, t_2, which are 1^0 apart. Then from Charles law, $V_2 - V_0 = \frac{V_0}{460}$, $V_2 - V_1 = \frac{V_0}{460}$, $V_3 - V_2 = \frac{V_0}{460}$ and so on. Join the points V_2, V_1, V_0, and continue the line until it strikes the X axis at some point X_1, which by construction must be 460 degrees to the left of the line OY, since it corresponds to 460 parts of V_0.

Call this new origin absolute zero, and let T represent the number of degrees from this zero, then $T_0 = 460$, and $T = 460 + t$.

Now, since $V_2 - V_1 = V_1 - V_0 = \frac{V_0}{T_0}$ by Charles Law, and from the geometry of the figure $\frac{V_0}{T_0} = \frac{V_1}{T_1} = \frac{V_2}{T_2} = \frac{V}{T}$,

therefore the expansion of the gas when heated one degree at any temperature t is equal to $\frac{V_0}{T_0} = \frac{V_1}{T_1} = \frac{V_2}{T_2} = \frac{V}{T}$ and the specific volume $V = V_0 \frac{T}{T_0} = V_1 \frac{T}{T_1} = V_2 \frac{T}{T_2}$ —which is the general equation representing the change in volume due to change in temperature.

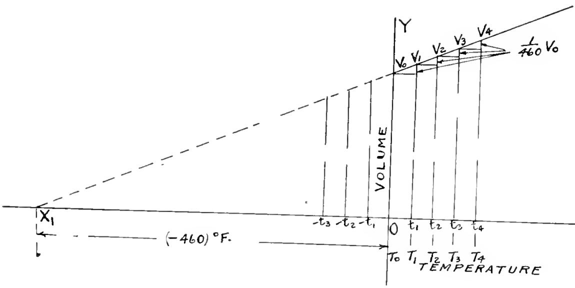


Fig. 4.

It is necessary now to bring the pressure P into the combination. It was determined by Boyle and Marriotte, independently that P times V is always a constant, if T remains the same. This established the relation called Boyles' or Marriotte's law that $P_0 V_0 = PV = P_1 V_1 = P_2 V_2 = C$, a constant for the same temperature and the same weight of gas. By combining the two laws analytically it is shown that since from Charles' law $\frac{V}{T}$ is a constant and from Boyle's law PV is a constant, therefore, by changing one at a time we must arrive at a conclusion that $\frac{PV}{T}$ is a constant quantity at all times. This is usually stated in the

form $\frac{P_0V_0}{T_0} = \frac{P_1V_1}{T_1} = \frac{PV}{T} = R$, a constant for a given kind of gas. This, however, does not explain the full physical meaning of the combination, neither does it explain the significance of the constant R, and as far as I have gone through the work there is always a link missing in the chain connecting these two experimental laws which can be unified only by referring to the thermodynamic relation of the quantities as follows:

Consider the pound of gas in the State of P, V and T as in Fig. 2 to be heated until the temperature is raised one degree F. If this is done with the movable plug, the volume will necessarily increase an amount of $\frac{V}{T}$, as in Fig. 3, which we have shown to be a constant quantity, whatever the value of V and T, since P is constant. We can heat the same gas one degree and not allow it to expand, by increasing the pressure against the plug, which will result in an increased pressure also on the inside of the vessel, but the volume will remain the same. It is evident that the amount of heat required to raise the same gas one degree will not be the same in both cases, because in one case it only heated the pound of gas one degree, while in the other case it also did actual work in displacing the plug against the outside pressure, and therefore it required an additional amount of heat equivalent to do that work. The heat required to raise one pound of a substance one degree is called the specific heat of that substance. Evidently the specific heat of a gas is larger when it is allowed to expand during heating than if kept in the same volume. The first is called the specific heat at constant pressure (C_p), the second is the specific heat at constant volume (C_v), the difference $C_p - C_v$ being the equivalent of the work done to displace the additional volume of the gas. The amount of work done in expanding the gas, or displacing the plug against the external pressure is the same as in any piston working in a cylinder and is equal to the total pressure in pounds times the distance moved in feet. Let "a" be the area of the plug or piston in square feet, "b" the length of the displacement in feet; then the total pressure is equal to P times "a" pounds and the work done

is equal to P times "a" times "b" foot pounds. Now "a" times "b" is the volume displaced by the rise of one degree, which was shown by Charles' law to be $\frac{V}{T}$, therefore the work is equal to $P\,a\,b = \frac{PV}{T}$ foot pounds. Call this work R; then $\frac{PV}{T} = R$ foot pounds.

Since the heat expended on this is $C_p - C_v$, the work equivalent is $J\,(C_p - C_v)$ therefore from the first law of thermodynamics $J\,(C_p - C_v) = R$, or $C_p - C_v = \frac{R}{J} = AR$ where A is the reciprocal of J.

R is necessarily a constant for any gas, representing the work in foot pounds done by one pound of the gas when heated one degree at constant pressure, or the equivalent of $C_p - C_v$ which is the same at any pressure as long as that pressure remains constant; so that $\frac{PV}{T} = \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} = R$, from which $PV = RT = J\,(C_p - C_v)\,T$, an expression which completes the relation of the three variables to each other and also shows their value in units of heat.

In the case of heating the gas at constant pressure, as in Fig. 3, you have an example of converting the amount of heat $C_p - C_v$ directly into work, while the quantity C_v is utilized to heat the gas, or wasted as far as work is concerned. If we heated the gas at constant volume as in Fig. 2, it will increase the pressure against the plug and according to our general equation, the increase for each degree of temperature, will equal $\frac{P}{T}$ pounds per square foot, since V is constant. This increase in pressure is available for external work and if we loosen the plug the higher pressure will force it out and increase the volume.

Now, if in this subsequent expansion we keep in touch with the supply of heat, the expansion will be what we call isothermal;

that is, while doing the work the temperature will remain the same, an amount of heat equivalent to this work which is $C_p - C_v$ will be added from the source of supply, the volume will increase to make up for the reduction of pressure according to Boyle's law, until the final condition is established as in Fig. 3.

If, however, in expanding to the lower pressure, the gas is cut off from the supply of heat, then the work of expansion is done at the expense of the heat previously added in raising the temperature, and the change in the state of the gas is called adiabatic during which the relation of the three variables is determined by the general equation $\frac{PV}{T} = \frac{P_1V_1}{T_1} = R.$

However, in arriving at the final stage we can determine only one of the variables and the product of the other two. For instance, if the change is made from a higher to a known lower pressure it will increase the volume and reduce the temperature. If the change is made from a higher to a known lower temperature it will increase the volume and reduce the pressure. That is, in finding the final state after the adiabatic expansion, we have two unknown quantities to solve for, and we need one more equation for the solution.

This was made possible by experimental facts established from another direction and known as the exponential law of Marriotte, according to which $P_1V_1^y = P_2V_2^y = PV^y =$ a constant where y is the ratio of the two specific heats of the gas or $y = C_p/C_v$.
By combining algebraically the general equation, $\frac{PV}{T} = \frac{P_1V_1}{T_1} =$ J $(C_p - C_v)$, with the exponential equation, $PV^y - P_1V_1^y$, we are able to find the changes produced in the quantities b an adiabatic change. You will find several forms of this combination worked out in text books on thermodynamics as for instance, $\frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right)^y = \left(\frac{T_1}{T_2}\right)^y$ and so on, which are merely algebraic solutions for the unknown in terms of the known quantities during an adiabatic change in the condition of a gas.

THE PRESERVATION OF WOOD FROM DECAY†

BY C. H. TEESDALE*

The preservation of timber from decay by injection with chemicals, although largely practiced in Europe for many years, has only developed extensively in the United States within the past fifteen years. Largely on account of the extensive supply of timber and the corresponding low cost, little attention to the conservation of the forests and their products was thought necessary. Of recent years, however, these conditions have changed. With a diminishing supply and an increasing demand for timber, there could be only one result—an increase in cost. In 1900 less than fifteen treating plants were in operation while at present there are over ninety either in operation or under construction.

WOOD STRUCTURE AND CAUSES OF DECAY

Before considering methods for preventing decay, the general structure of wood and causes of decay should be understood. Briefly, wood is composed of a series of long, closed tubes extending parallel to the long axis of the tree. These tubes, sometimes known as vessels and tracheids, are firmly united laterally and fitted together endwise in the form of a splice.

Contrary to a somewhat popular understanding, decay is not due to an internal disintegration of the wood fiber of its own accord, but is produced by the action of low forms of plant life called fungi, which feed upon the wood cells and their contents and cause disintegration. These organisms develop in the wood in the form of minute threads collectively known as "mycelia." These threads frequently form on the outside of the wood what is termed as the "fruiting body," familiar examples of which being the toadstool-like growths so often seen upon railroad ties and other timbers affected with decay. From the "fruiting bodies" come the spores which are blown about by the wind and attack the various forms of wood suitable for their development.

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†Address given before the Chicago Section of the American Chemical Society, March, 1914.

*Class 1908. In charge, section of Wood Preservation Forest Products Laboratory, United States Department of Agriculture, in cooperation with the University of Wisconsin, Madison, Wisconsin.

Necessary for the development of the fungi, however, are requisite amounts of air or oxygen, moisture, food, and heat. The complete elimination of any one of these factors will prevent decay. Illustrative of this is the long life of timbers completely buried under ground or submerged under water, under which

Forest Products Laboratory, Madison, Wisconsin.

conditions there is an insufficient supply of air or oxygen for the development of the fungi. For most conditions, however, it is only feasible to destroy the food supply by impregnating the wood with materials poisonous to the fungi; it is on this theory that modern methods of timber preservation have developed.

SELECTION AND PREPARATION OF MATERIAL FOR TREATMENT

The success of any preservative treatment depends very largely upon the proper selection of the material. First, it is essential that the species selected be adapted to impregnation; and secondly, it is preferable to treat the species not naturally resistant to decay.

Of equal importance to the selection of the material is its preparation. All wood contains considerable moisture when first cut. By one means or another, it is essential that much of this

moisture be removed before the preservative can enter. In other words, the material must be seasoned.

Subsequent to peeling there are several ways in which the timber may be seasoned. The most general and satisfactory method is to stack in piles and allow to air-season. The method of piling and duration of seasoning will, of course, depend upon the size, form, and species of timber and the local weather conditions. Under all conditions, however, it is essential that the material be so piled as to admit the ready circulation of air and drainage of water, care being exercised to prevent excessive checking of the material through too rapid seasoning.

It sometimes happens, especially in the South, that treating plants can not hold their material long enough to thoroughly air-season it on account of conditions which cause very rapid decay. For this, and sometimes other reasons, recourse is frequently had to artificial methods of seasoning, such as steaming or boiling the material in the preservative prior to impregnation.

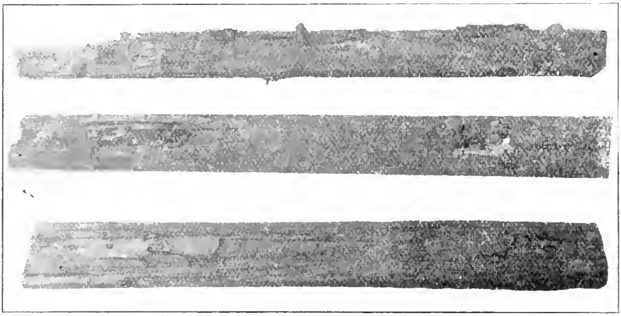
PRESERVATIVES

The preservatives in general use may be divided into two main classes; viz., oils and salts: Of the former, coal-tar creosote or dead oil of coal tar is undoubtedly the most widely used and generally recognized as an efficient preservative. Produced as it is by the distillation of coal-tar, its constituents are most complex, depending upon the character of the coal, temperature of coking, and temperature limits of the distillation of the tar. In general, however, the commercial product is the distillate coming over from the tar between a temperature range of from about 200° C. to 350° C., and consisting of varying amounts of phenols, or tar acids, naphthalenes, and anthracenes, and their compounds. The merits of these various constituents are open to much discussion. For most purposes the high boiling fractions are probably the most permanent and lasting in the wood, and creosotes containing relatively large percentages of these fractions are generally considered the more desirable.

The creosote produced from water-gas-tar is quite similar to the coal-tar product. This product is used to some extent under its own name, but more frequently under the guise of coal-tar

creosote. It is difficult to clearly differentiate between the two, the most important difference being in the character of the hydrocarbons forming their constituents. Whether or not a coal-tar creosote is any better as a preservative than one from an oil tar, has not yet been definitely settled. Many claim that the latter will prove equally efficient, and it is known that much of the product now sold under the name of coal-tar creosote consists largely of either oil tar or the creosote therefrom.

Wood creosote, or creosote produced from the distillation of wood tar, may also be mentioned in the class of *oil* preservatives. However, the production of this material is so limited that it can not at present be considered of first importance in commercial treatments.



Untreated Sap Pine Ties Badly Decayed After Three Years' Service Under Heavy Traffic.

Referring now to the use of chemical salts: The success of such material in preserving timber depends primarily upon the antiseptic properties of the salt and its solubility in water, and secondarily upon a number of points, such as the effect upon iron and steel as used in the construction of treating plants, and the presence of acids or other chemicals which will cause disintegration of the wood. For such causes as the former, the use of copper sulphate and mercuric chloride, both excellent antiseptics, has been practically abandoned. Zinc chloride, however, has withstood the test of time, and is extensively used in

this country. It is generally applied in the form of a $2\frac{1}{2}$ per cent to 4 per cent aqueous solution, the aim being to inject about

Creosoted Sap Pine Tie Practically Sound, Though Badly Rail Cut, After 33 Years' Service Under Heavy Traffic.

one-half pound of the dry salt to the cubic foot of timber. As with all salt treatments, the chief objection is the subsequent leaching from the timber after treatment. It is evident that such a preservative is not well suited for timber to be used in very damp and wet localities. It will never do for the preservation

of piling. But when the material is to be placed in comparatively dry regions, and when, aside from decay, the mechanical life is limited, zinc chloride may be advantageously utilized.

In comparing the relative merits of coal-tar creosote and zinc chloride, the cost of each must be considered. Creosote, although without doubt the most effective preservative at present in use, is also the most expensive, its price in bulk being from eight to ten cents per gallon. At least one-half gallon and usually one gallon is injected per cubic foot of timber. On the other hand, sometimes as much as three gallons of the solution are used with zinc chloride, costing about four cents a pound. It is customary to inject not more than one-half pound of the dry salt per cubic foot and frequently less. It is evident from this that for timber whose mechanical life is such that the full benefit of the creosote can not be obtained, the greater economy will accrue from the use of zinc chloride, either alone or in combination with a small amount of creosote.

PROCESSES

In applying a preservative to timber, it is the prime object, first to secure a certain requisite absorption, and secondly, to distribute the preservative throughout the wood as uniformly as possible. There are a variety of methods for accomplishing these results, which may for convenience, be classified into brush, open tank, and cylinder treatments.

The first of these, as the name implies, consists of applying the preservative with a brush, in other words, merely painting the material. It is the most simple and the cheapest in first cost. Also, it is the least efficient of the methods. Only small absorptions and slight penetrations can be secured with this method, and it is applicable for use only with preservatives of the oil class. Such treatment, however, is better than none, and for general conditions will more than pay for itself if properly applied. It is suited for the butt treatment of poles, posts, etc., when the quantity of material to be treated is insufficient to warrant the installation of a plant. When used, the preservative is applied hot, and at least two coats, preferably three, should be given.

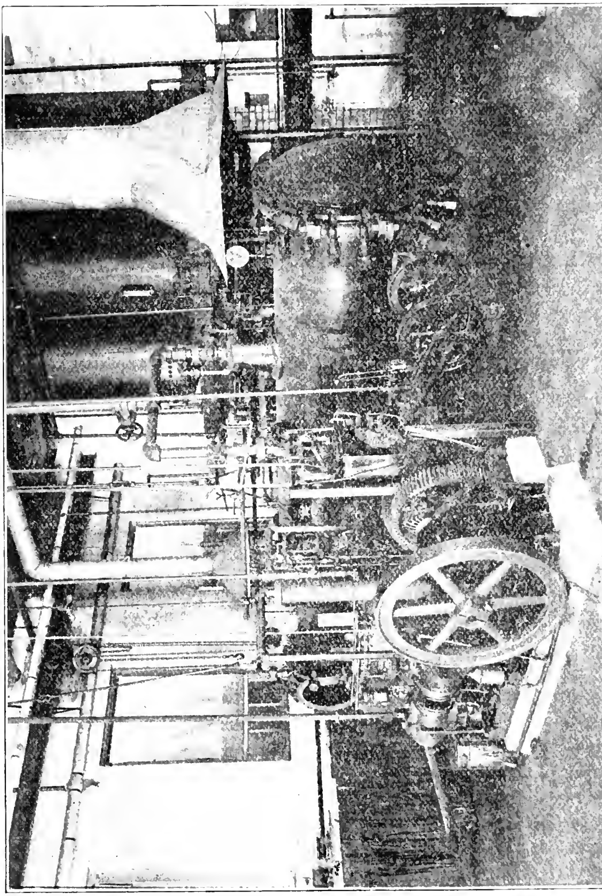
With the open-tank method, the material is submerged in a tank containing the preservative and is there boiled for a period varying from one to five hours, according to the character of the material and the absorption desired. This has the effect of expanding and driving out of the intercellular spaces of the wood a portion of the air and moisture therein contained. After this heating, the charge is either allowed gradually to cool in the preservative, or the hot preservative is quickly transferred from the heating tank, which is at once refilled with relatively cool preservative. During this cooling, the remaining air and moisture in the wood contracts, forming a partial vacuum, which is in turn destroyed by the entering preservative. This method of treatment is simple, requiring but little and inexpensive equipment.

Although the above two methods will serve the special purposes to which they are adapted, practically all commercial treatments of appreciable size are conducted under the *cylinder class.* The material is here loaded on small trucks which are run into horizontal cylindrical retorts fitted with track and steam coils. The doors on the ends of the retort are then bolted, the cylinder is filled with preservative from the storage or measuring tanks, and pressure sometimes as high as 200 pounds per square inch is then applied to the charge wtih the force pumps. When the gauges on the measuring tanks indicate that sufficient preservative has been forced into the material the pressure is relieved, the cylinder is emptied and the charge is removed. Many of these plants with their full complement of retorts, tanks, pumps, boilers, cylinder cars, derricks, locomotive cranes, storage yard, fire protection, and necessary buildings, cost several hundred thousand dollars, and have an annual capacity of nearly 10,000,000 cubic feet.

ECONOMIC ASPECTS

The successful development of any preservative treatment, of course, depends fundamentally upon the ultimate financial saving. A decrease in the costs must ensue to justify its existence. This ultimate reduction in costs rests directly upon two prime factors, viz., the relative durability and the relative first costs of the treated and untreated material.

There is practically now no question but that the natural dura-



Section of Wood Preservation at the Forest Products Laboratory.

bility of timber is much increased by the proper application of a preservative. The Committee on Wood Preservation of the American Railway Engineering Association have published much valuable data on durability of timber in its Proceedings.

The preservation of wood from decay offers one means of lessening the drain upon our forests. In Forest Service Bulletin 118, the average life of creosoted ties properly tie plated is estimated to be from 14 to 20 years, depending upon the species used. Similar ties treated with zinc chloride are estimated to last from ten to twelve years, provided they are not placed in a very wet location.

Soon after the organization of the Forest Service, the subject of wood preservation was deemed of sufficient importance to warrant research work on wood preservation, and a small laboratory was started. When the Forest Products Laboratory was organized in 1909, the scope of this work was greatly enlarged.

The work which is now being carried on at the laboratory is a study of those problems which will be of most assistance to the wood preservation industry. This includes problems which are of direct interest to the treating plants from an operating standpoint, for example, the proper handling of timber to obtain the best service results. Also problems are studied which are of direct interest to the user of treated wood, for example, definite information on the life of treated and untreated material and the relative value of different preservatives for preventing decay.

More specifically some of the problems upon which the laboratory is now working are:

1. Development of new wood preservatives.
2. The comparative efficiency of various wood preservatives now on the market.
3. Experiments on the mechanical operative features of wood preserving plants.
4. Relative resistance of various species of wood to injection with preservatives.
5. Temperature changes in wood while being treated.
6. Relative resistance of wood to decay.
7. Methods of satisfactorily treating Douglas fir.
8. Inflammability of wood and the relative effect of various chemicals in retarding fire.

THE DIESEL ENGINE AS A TYPE— ITS CHARACTERISTICS AND ATTEMPTS AT MODIFICATIONS*

BY R. W. CROWLY

Every now and again, when some striking new achievment of the Diesel engine has earned for this class of machinery a widespread and assertive publicity, the files of the Patent Offices throughout the world record the fascination which this wonderful invention of twenty-two years ago never ceases to exert over those who stop to contemplate its features for the first time.

The profound man brought into contact with the Diesel engine is generally impressed by some aspect of the nature of the machine itself, of its operation or of the material results it produces. The reflection, for example, that this single piece of machinery can stand anywhere in absolute and undisturbed repose, ready at instant bidding to convert within itself and without external agency the energy which in earlier ages has been concentrated in the oil that flows through the small pipe to the engine, almost conjures up a vision of energy by direct supply service .

This is a marvel of engineering. Right there within a cylinder are carried on all the process which, under other conditions, require the aid of coal conveyors, chain grates, boilers, smokestacks, economisers, feed-pumps, feed-water-heaters, engines, condensers, air-pumps, etc., or again under other circustances a gas-producer, cooler, scrubber, tar-extractor and recovery plant. Even the gas engine of the oil fields, direct-connected as it is to a natural source of energy, affords no approachable comparison to the Diesel engine as an independent, self-contained converter of energy, for electricity must be brought to the gas engine's aid and the gas engine must be taken to the

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Editor's Note: We are assured that any of the alumni of Armour Institute of Technology will be warmly welcomed at the McInotsh & Seymour Corporation's works, at Auburn, New York, where he can witness tests and have the operation of the Diesel engines fully explained to him.

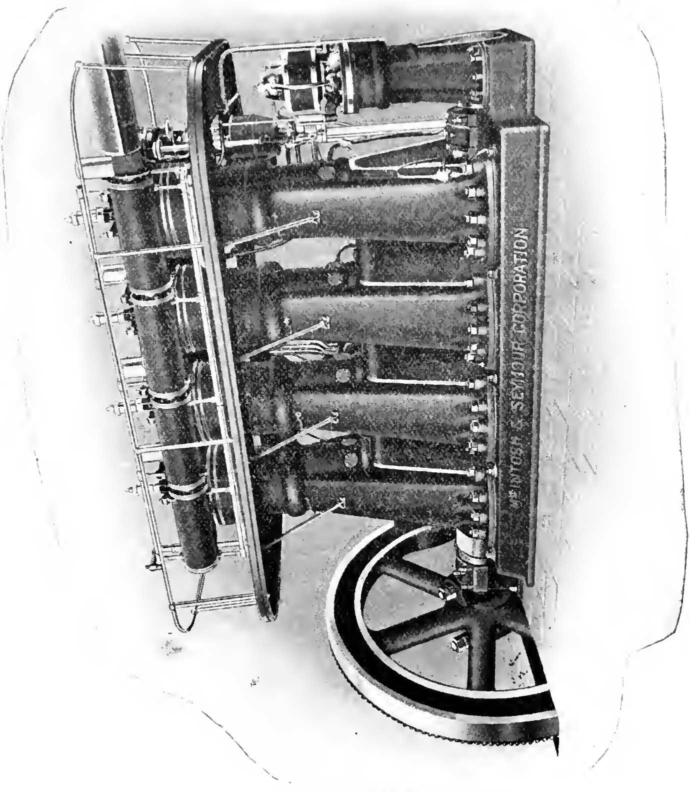
*This paper was secured thru the influence of E. S. Church, Class of 1897, President of the McIntosh Seymour Corporation.

fuel supply. And with the blast-furnace gas engine comparison is yet more distant, a great plant standing back of it, for all one thinks of the supply as costless waste. The gasoline engine, with the so-called "self-starter," makes a delusive claim for thought, but it has a mate in electricity, and without that mate it is powerless.

Alone, incomparable, unmatched, the Diesel engine remains the unique example of a prime mover furnishing power directly and without intermediary by the conversion of energy from the handiest, most manageable and most easily transported fuel, namely oil. Mineral oil, vegetable oil, animal oil—all have been used. In most lands the residuals or heavy distillates from petroleum are favored; in other countries the tar-oils are extensively used; and in the tropics experiments have been made with oil from the palm tree. The engine is ubiquitous; its service universal. It works at the top of the world and at the bottom, operating with the same wonderful facility and efficiency on the mountain crest as in the quarry pit. From Pole to Equator it has found its field, and over 2,000,000 horse-power is to-day being furnished by it in different parts of the globe.

It is with such reflections as these in mind that one must approach the Diesel engine if one would appreciate it at its worth and learn to know it as it should be known. No man without deep respect for the engine has ever yet succeeded with it. To have grasped what a great triumph of invention it is, and to have understood the import and significance of the processes that take place in it is to have gained some of the inspiration essential to fruitful association with it. Numerous patents relating to Diesel engines are a monument to the folly of that conceit which moves men to believe that a "paper" knowledge of the cycle of operations fits them to deal with problems of improvement.

What is there to distinguish Diesel's final experimental engine of 1897, from the Diesel-type engine of this present date? Variations you may note of frame design, of crankshaft dimensions, of valve-openings and of such other details as depend upon regular engineering practice and experience, but you will search in vain for fundamental changes. Every part of that 1897 engine, now in the Munich Technical Museum, is in accord with



500 H. P. Diesel Engine.

the four-cycle Diesel engine practice of this very year. The progress that has been made is not of a character which the Patent Office files record; it has been a progress of foundry practice, or heat treatment, of metallurgy, of machinery operations, of fuel-injection, of compressor efficiency, of lubrication and such like matters. Therein has progress been marked.

From the very beginning of the engine's commercial history, that is to say, since proof was afforded that Diesel's conception was industrially valuable, efforts have been made to improve upon the details of the original design. During the early years only those who were intimately connected with the production of this type of engine attempted the variations. None of the efforts were fertile, but mostly they were founded upon an intelligent basis and had the merit of being inspired by men who had sufficient experience not to underrate the difficulties of their ventures. In the last ten years, however, the calibre of the patents applied for in connection with Diesel-type engines has markedly deteriorated, and in more recent times there has been evidence of much incomplete analysis and of much ignorance of the problems touched upon.

As an instance: In no single direction has so much endeavor been expended as towards the elimination of the compressor that supplies the air for the injection of the fuel. Diesel himself provided at first a pump-forced injection, but not until he adopted the air-blast for the delivery of the fuel into the combustion space did he obtain satisfactory results. About 1901 or 1902 the Swiss licensees reduced their compressor to a single-stage air-pump which took its supply through the working cylinder at the pressure ruling on the last of the compression stroke, but this had to be abandoned. Later some notable work was done by Trinkler and by Haselwander in the attempt to abolish the air-bottles entirely, though retaining a very small air-pump. Both these clever engineers persisted for several years in their work, but finally had to acknowledge that the conditions incidental to the operation of the engine defeated them. At Augsburg, where the engine was originally developed, there has been even in these last two years a compressorless Diesel-type engine, but its performance has not encouraged the firm to place it upon the market. Many more experiments of similar nature could

be cited, all unsuccessful but all characterised by sufficient initial promise to have earned the approval of the engineers directing the fortunes of some of the finest engineering works in Europe. In defiance of these recorded experiences, and obviously in many cases without regard to them, inventors still come forward with patents that are demonstrably useless. As it has been with the air-compressor details, so has it been with many other details of the design. Invention is to be encouraged and not repressed, but let discrimination be drawn between invention and that form of imaginativeness which is begotten of blind and lazy groping after an idea. It may usefully be added that other people's failures should not act as a deterrent from the pursuit of a well founded conviction, in illustration whereof it may be told that one of the great British armament and naval construction firms developed a Diesel-type engine in which the air-system is completely eliminated, and this feature is common to nearly all the British submarine engines—it is, however, a compromise suiting special conditions.

Particularly since the movement towards the development of the Diesel engine for marine work started have the variations of construction increased. The two-cycle style and the double-acting four-cycle arrangment have been practised for powerful stationary engines without finding much favor, though undoubtedly their time will come when greater constructive experience has been gained, yet for the much more arduous and much more severe conditions of marine work the astonishing development has occured of both single-acting and double-acting engines of the two-stroke and four-stroke classes, every one characterized by special features of its own, until the variety of construction has become almost bewildering. And what has been the lesson?

Inland engineering firms of no marine experience and engineering firms of no Diesel engine experience have spent huge sums of money in the production of machinery that is far from satisfactory and of all the ocean-going motor ships that have been put into service those only are successful which have engines built by marine firms that had experience of stationary Diesel work before they turned to the marine Diesel machinery. The lesson is clear for those who care to read: namely, Diesel engine construction can be successful from the start only if the accumulated experience of years is available to guide it. And

that is why in an earlier paragraph stress was laid upon the importance of having a deep respect for the engine. If you do not respect it you will not appreciate its problems, you will not realize their intensity and you will consequently fail to meet the exacting demands it makes upon those who desire to produce it as a trustworthy piece of machinery.

Not all the American firms who have commenced to build Diesel engines have recognized the importance of this lesson, and some of those who have read it and profited from it have ignored other essential considerations. There are, however, some successful adoptions of Diesel engine construction. Among them is that of the McIntosh & Seymour Corporation of Auburn, New York, which is at the present time very actively engaged in Diesel engine production.

By direct association with the oldest European factory wholly devoted to Diesel engine construction, the McIntosh & Seymour Corporation has assured itself of the benefit of unexcelled experience and guidance. Not a single detail of design or construction has been altered, and so careful has the American firm been to reproduce every advantage of the European engine adopted for model that it is importing the special grades of iron which have assisted to build up the engine's reputation in Europe. New machine tools have been laid down to satisfy the higher standards of accuracy introduced into the shops, the tolerance on many parts of the engine being so fine as half one-thousandth of an inch. Men who have been brought up and trained with Diesel engines have charge of the erection of the engines, and so smoothly and truly and well are the European conditions reproduced that the test records of the McIntosh & Seymour engines show a fuel consumption equal to the very best attainable. On a 500 H. P. engine, such as the illustration depicts herewith, the rate of consumption is measured at only 0.407 lbs. per B. H. P. hr., which is well below that usually reckoned in this country. The engines at Auburn are being built in sizes up to 1000 B. H. P., and the production is now so regular that tests are being run practically every day. Two of this firm's Diesel-type engines are being exhibited at the Panama-Pacific Exposition, and amongst the larger orders in hand are a group of four 500 H. P. engines for Texas and a pair of 500 H. P. engines for Arizona.

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Are we wiser than our fathers? The field of human knowledge has broadened, aye, and deepened too, since our fathers were taught in one or other of the schools—perhaps both—of experience and of book-learning. Tennyson says, "Knowledge comes but wisdom lingers." That poet and prophet recognized the distinction and had well learned that the knowledge lodged in a richly stored brain is not always wisely used. There have been learned fools and such are not infrequent in our own day. Wisdom is the essential element in the practical affairs of life, but wisdom links the ideal to the practical. Wisdom helps him who has it, to meet the hard things of life and points the way toward the attainment of better things. Our forefathers in wisdom laid the foundations upon which the greatness, the pros-

perity and the glory of our country have been builded ,and we, their heirs in this goodly heritage, must pass it on to our heirs enriched by our labors and more glorious for the ideals which we have woven into her history.

This is a practical age; if you please, a materialistic age, and what we need is a wise idealism to counteract the tendency to make the acquisition of material things the measure of human success. The young man striving to acquire an education too often looks upon the knowledge that he seeks just as the miner looks upon his pick as a tool to dig a living with. The pressure of poverty upon him and he is earnestly intent upon securing the dollars which will relieve his necessities. It is right that he should bend his energies toward the relief of his necessities, but his eye should not be so focused upon the dollar that it cannot take in the wider vision of a future in which he may, if he will, play a worthy part. Possibly his environment has not been one which has brought him in contact with men and women whose nobility of thought and conduct could inspire in him a desire to make his life accord with their high standards; and the one perfect example which the Christian religionist would have him accept in the "Man Christ Jesus" may seem by reason of a separating gulf of two thousand years, too far removed from the life of today to fit into its changed conditions.

Such a one may take as his example, his standard of living, some modern man who has "made good" and stands for successful attainment; whose life has fallen short of the perfection of the Great Ideal, but yet offers an inspiration to the young man who has not caught the higher vision. Such a man a few months ago reached the end of a career which should be an inspiration to any young man on the threshold of his lifes' work. This man grew up on a farm in Michigan. Two days after his 18th birthday in August, 1862, he enlisted in the 24th Michigan Infantry Regiment, which regiment was one of the units of the famous Iron Brigade. He served first as a private and then as a sergeant until the end of the war, in which he participated in some of the fiercest battles. He came out of these years of stress, danger and temptation, unscathed by the corrupting influences which beset the soldier's life. Having served his country in the field of war, he felt that he could serve her better in the avocations of

peace, and he set to work to earn the means of paying his way through college. He entered the University of Michigan in the School of Engineering and graduated with honor in the class of 1870. He entered the service of the Government; became Assistant United States Engineer in charge of lock construction at Sault Ste. Marie, Michigan, where today the "Weitzel Lock" and the "Poe Lock" stand as monuments to his fidelity and skill. He then left government employ and engaged in bridge building as Engineer in charge of erection, and later as designer. These bridges span the Mississippi, the Ohio and other streams. The years rolled by and the Government requisitioned his services again on most important commissions such as the Deep Waterway from the Great Lakes to the Atlantic Seaboard, the Nicaragua Canal and other inter-oceanic canal routes, and later on The International Engineering Commission on the Panama Canal. On this Commission he was one of the minority of five American engineers whose recommendations prevailed over those of the five foreign and three American engineers who reported in favor of the sea level route. In other important matters he served the Government. The crowning work of his life was for the Pennsylvania Company in connection with their great terminals in New York.

He was honored by his Alma Mater with the degree of Doctor of Laws in 1895, and in 1904 the University of Wisconsin conferred upon him a like honor. He was elected President of the Western Society of Engineers in 1898 and in 1903 he became President of the American Society of Civil Engineers. In 1910 he was awarded the "John Fritz' 'medal and in the same year was elected an honorary member of the Institution of Civil Engineers of Great Britain, a distinction never before conferred upon an American. In 1912 The Franklin Institute conferred upon him the "Elliott-Cresson" medal "for distinguished achievement in the field of engineering."

This great man was modest to a degree. His human sympathies were strong and he commanded not only the obedience of his subordinates but their love and admiration.

He was strictly just and his honor was never sullied.

This worthy example for any yonug man was Alfred Noble who, without self seeking, attained success and honor by doing

the task which duty or opportunity placed in his way, to the very best of his ability. "Wisdom is justified of her children."

—*Isham Randolph.*

Chicago's Revamped Municipal Garbage Plant made a net profit to the city of $5,764.49 for the eleven months it operated in 1914, according to the Health Department. For nearly five months of this time, during the rehabilitation period, there was a considerable labor charge before any income could be derived. The two largest items of the $129,708.09 outgo are $75,678.49 for labor and $30,052.96 for fuel oil. Receipts were $113,701.55. Dr. G. B. Young, health commissioner, credits against the apparent loss the proportionate amount the city formerly paid a contractor for the service—$47,500 per year—and then deducts an interest charge on the $683,000 investment of $21,770.63 to give the profit mentioned. —*Engineering Record.*

An ordinance recently formulated by the City of Chicago law department provides among its restrictions that all trucks shall have rubber tires overlapping steel tires; that the weight of vehicle and load shall not exceed 750 lbs. for each inch of tire width, the maximum weight allowed being 28,000 lbs.; that for freight-carrying purposes no truck shall be more than 90 inches wide or 26 feet long, and that for passenger carrying purposes 8½ feet should be the maximum width. Speed of trucks is to be based on capacity and will range from 6 to 12 miles an hour. Loads shall not project more than 4 feet past rear end of truck, except during early morning hours and late at night. The ordinance has been presented to the judiciary committee, and a copy to the local transportation committee. —*Engineering Record.*

As soon as the public is educated to the necessity of fire prevention, then the first resistive building will appeal to them. Since the fire resistive building will appeal to them, the owners will build to suit the public demands. Public opinion will then be more in sympathy with the aims of the insurance companies to enforce their building code. There is no doubt that the education of the public from a fire protection viewpoint will result in a better building standard. —*Safety Engineering.*

An invention (U. S. 1,122,062—December 22, 1914) is announced by Charles Bittner, Stafford, Kansas, for the process of hardening and welding copper. It is said to provide a simple, reliable and efficient method, together with a compound, by which the metal can be quickly hardened, or rapidly welded while being hardened, so as to make a strong union. A composition of acidified hyposulphite and sulphite of soda with acetic acid and alum. The powdered composition is successively applied to various portions of the copper to be treated and at a low heat. The operation is repeated, at which stage the metal is soft enough to be hammered or welded into the shape desired. Copper so treated, it is claimed, will take an edge and be sufficiently hardened for cutting purposes without any tempering.

—*The Iron Age.*

Dr. Henry S. Pritchett, President of the Carnegie Foundation for the Advancement of Teaching, in an address to the Engineering Foundation says, "Research considered as a process of scientific thinking and discovery is not a task to be set before the immature and untrained. It is quite true that the best training for research may not always lie in university halls. A long roll of illustrious men whose names the world cherishes found their way to the solution of the great problems of science and of industry by other paths than the university. This means simply that they became thinkers in their own way.

The process of research . . . involves first the clear formulation of problems, and then the attack upon the problem by all the avenues and the agencies of science. True research implies clear thinking, minute knowledge of the field of science, and patient endeavor."

—*Journal of the American Society of Mechanical Engineers.*

Annual expenditures for road improvement in the United States amount to about $204,000,000, according to the report of the Joint Congressional Committee on Federal Aid to Good Roads. Automobile licenses bring in $8,000,000 annually. County, township and district road bonds were voted in 1913 to the extent of $50,635,000. —*Engineering Record.*

SOLDIERS OF PEACE*

BY LESTER C. GUSTIN

Northward across the "Circle"
  Where the stalking snowstorms creep,
Westward across the desert
  Where the burning sandstorms sweep,
Southward amid the fevers
  Where tropic death-shafts light,
The Soldiers of Peace are fighting
  Their never ending fight.

Not in the swirl of conflict
  'Mid crash of the smoking guns,
On the crest of a wild charge surging
  Their toil-worn pathway runs—
But slowly with tape and transit,
  With shovel and pick and steel—
Til the wondering jungles echo
  To the hum of the spinning wheel.

On the shores of the Northland oceans
  Where the stinging sleet claws grip,
Their sea-walls mock the ice packs
  That harry the battered ship,
And the whining storm wind mutters
  As the sheeted hulk tears free,
Safe to a man-built harbor
  Wrest' from an angry sea!

Through the burning land of dead things
  Where the demon Sun God rules
Their coughing pack trains stagger
  Bringing supplies and tools
To detachments of dauntless workers,
  Who laugh at the heat and thirst—
Til the shimmering steel tracks conquer
  The land that God had cursed.

In the heart of the sunny Southland
  Where the sultry breezes sigh,
The song of their panting dredgers
  Flings echoes against the sky,
And the lazy water gurgles
  As it chafes at its earthen chains,
As the levee walls rise firmer,
  A guard for the sheltered plains.

Through the everlasting mountains
  Their pounding rock drills bite,
And the yawning tunnels open
  To the smash of their dynamite,
Or a water pathway lengthens
  O'er the back of a great divide,
Where their huge locks lift the liners
  Up the frowning mountain side!

*Reprinted from the Engineering News, issue of October Fifteenth.

On the floors of the rushing waters
  Through the mud and the silt they go,
Sinking their steel-shod cassions
  To the yieldless rock below,
Digging down through the darkness,
  Fighting the flood with air—
Till the bridge piers breast the torrent
  And carry a pathway there.

When the flickering shadows lengthen,
  And the glowing embers pale,
Their toil-scarred veterans gather
  On many a lonsesome trail,
Snatching a moment's freedom,
  Ere break of another dawn,
With a thought of the deeds of tomorrow,
  A sigh for their comrades gone.

On the stretches of far Alaska,
  On isles of the restless deep,
On the prairies of Central China,
  Their unknown heroes sleep,
Where the Congo seeks the ocean,
  By the Orinoco's head,
'Neath the skies of a hundred nations,
  Slumber their nameless dead.

By a boiler's wild explosion,
  By the redskin's feathered dart,
'Mid the chaos of twisted girders
  When the great bridge trusses part,
By the burn of the wasting fever,
  With a smile as the pale lips blue,
A curse that their work is finished,
  A prayer that the job goes through!

By the creak of their straining derricks,
  By the drum of their hammered steel,
By their walls on the storm-lashed ocean,
  Where their rock-ribbed watch dogs peal,
By the stretch of their water ditches,
  By their rails through the trackless wood,
Ye shall know their work when ye see it
  And know that their work is good!

Eastward across the surges
  Where the Old-World nations lie,
Westward amidst the mountains
  That shoulders aside the sky,
Hereward among the cities
  In the sickly arc-glow light,
The Soldiers of Peace are fighting
  Their never ending fight.

Their's not the victor's laurel
  When a hard fought field is won,
No cheers of a grateful people
  But pride in a task well done;
No blare of the conqueror's trumpet,
  No garlands of flowers cast
But the sight of a work well builded,
  And a faith that that work will last!

ARMOUR INSTITUTE OF TECHNOLOGY BRANCH OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

There has been one meeting since the last issue of the Engineer. This was the regular meeting held on February 4th in the Physics lecture room.

Mr. F. L. Faulkner, '15, read a paper on the adaptibility of the eight cylinder V-type motor to the automobile. The paper as read presented some facts in regard to the eight cylinder V-type motor which showed up the main advantages of the motor, and its very few disadvantages. The conclusion reached from actual tests showed the eight cylinder motor to have a decided advantage over either a four or six cylinder mortor for automobile work. The different types of eight cylinder V-type motors were explained and slides were shown of the principal representative makes.

Besides having presented a very creditable paper, Mr. Faulkner deserves credit for being the first student this year to give a talk at any of the meetings. —*J. A. Agee.*

ARMOUR INSTITUTE OF TECHNOLOGY BRANCH OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

A meeting of the Armour Branch of the American Institute of Electrical Engineers as held in Science Hall, Thursday evening, February 18th, 1915. Mr. Henry A. Morss, of the Simplex Wire and Cable Co. spoke on the manufacture of rubber covered wires and cables. The lecture was illustrated by motion pictures and stereoptican slides which showed the process of covering wire and cables with rubber compound and wire and lead shielding. Also the method and the apparatus used in testing the insulation were shown.

Professor Freeman acted as chairman and introduced the speaker. This was the best and largest meeting held by the Armour Branch this year. There were 129 present at the meeting. —*C. F. Wright.*

THE CIVIL ENGINEERING SOCIETY

On February 9th the Armour Civil Engineering Society held its annual election of officers for the ensuing year. After all old business was disposed of in due form the election took place. The results were as follows:

President .... H. A. Rook
Vice-President .... L. J. McHugh
Corresponding Secretary .... Adams
Recording Secretary .... H. W. Hemple
Treasurer .... F. C. Armstrong
Board of Direction:—
Faculty Member .... Prof. Wells
Student Member .... A. C. Wermuth

After the election L. D. Hook gave the report of the treasurer in his usual interesting manner. Prof. Phillips was next called upon to give a few remarks. He responded with a short but extremely interesting talk, and with some very good advice to the new officers elect. He advised them all to get an early start and make the coming year one of grand success. Prof. Wells was also called upon, and he, likewise, responded in his usual charming manner.

A motion was then made to adjourn to the eats. Some swell eats and smokes were then brought in by the Social Committee. Everyone present forgot his cares and worries and enjoyed a most delightful evening.

The fellows were enjoying themselves so much that they forgot all about the time and consequently John, our old friend the officer, had to put them out.

On Tuesday, February 23, the society was very fortunate in having with them Mr. Kelleher of the Universal Portland Cement Co., who gave a most interesting and instructive talk on modern concrete road construction. He had slides of different roads taken during the various stages of construction which he used to illustrate some of the points of his lecture. He explained in detail every step during the construction of a road, from the initial grading to the final finished surface. He also pointed out

the duties of the engineer on a job of this sort; and the way he should conduct himself in order to get the best results from the workmen. We are sorry that we did not have a larger attendance present to get some of these valuable facts and ideas.

On Tuesday, March 23rd, we will be fortunate in having with us Mr. Chas. S. Holcomb, of the Board of Supervising Engineers, who will talk on inspection work. A real treat is in store for all who come, so everyone is cordially invited to be present at this meeting. —*T. J. Kiene.*

THE ATELIER

As the school year draws to a close, nearly every one in the department is buckling down to work.This is more evident than in former years, for with the advent of several new instructors, a different spirit has come over the school. The Seniors are working on the Traveling Scholarship problem, "A Cardinal's Palace," which is due on April 3rd. This is the last problem of the year, with the exception of the thesis. The Juniors are working on the sketches for their new problem. Their last problem, "A Soldiers' and Sailors' Monument," was handed in last week, but has not yet been judged. The Sophomores are preparing the final drawings for "An Administration Building for a Terra Cotta Company," and the Freshmen have nearly completed their design, "A Shelter for a Fountain."

On February 8, Mr. Fleming, of the American Sheet and Tin Plate Company, gave an interesting and instructive talk to the Juniors and Seniors on the manufacture of sheet metal and of copper alloyed steel. The latter had not been used to any great extent until a few years ago, when the American Sheet and Tin Plate Company experimented with it and found it to be of sufficient value to builders to manufacture it extensively and push its sales along this line.

The Junior class recently made a trip to the drafting rooms of Graham, Burnham and Company, and on May 12 the Seniors inspected the offices of Holabird and Roche in the Monroe Building. These inspection visits are very instructive and valuable to the students, especially to the Seniors.

Mr. Shattuck has very generously given his help to the education committee of the Atelier in obtaining a number of interesting speakers for the Atelier Smoker, to be held in the near future. Among those who have already been obtained for talks are Mr. Jensen, of the firm of Jennie, Mundie and Jensen, who will talk on "Hospitals," and Mr. Fellows, of Perkins, Fellows and Hamilton, who will tell us of some of his impressions during his recent trip to Japan.

This year the architects have been unusually fortunate in having the Scanlon lectures, which are held in Fullerton Hall, wholly dedicated to architectural subjects, with such men as Ralph Adams Cram, Claude Bragdon and Thomas Hastings as the speakers. Their addresses, so far, have been interesting, in that they have given the ideas and ideals of men who have made their lives a success by the following of these very details.

Mr. Campbell had the honor of having quite a number of his water color sketches hung in the exhibition of the Association of Chicago Artists, which was recently held in the Art Institute.

Mr. Shattuck, head of the department, was recently bereaved by the news of the death of his father, who for many years was a member of the faculty of the University of Illinois. We desire to express the sympathy of the students to Mr. Shattuck at this time. —*E. W. Porter.*

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(Signed) AL. N. GROSSMAN,
Business Manager.

Sworn to and subscribed before me this 13th day of March, 1915.

[Notary Seal] JULIA BEVERIDGE,
Notary Public.

My commission expires January, 8th, 1918.

THE ALUMNUS

Being That Part of *The Armour Engineer* Devoted to Personal Mention of the Graduates of the Armour Institute of Technology and to the Affairs of the Armour Alumni Association.

Edited by the Publication Committee of the Armour Alumni Association.

F. R. BABCOCK F. T. BANGS F. G. HEUCHLING

Communications should be addressed to F. G. Heuchling, 1310 Glenlake Ave., Chicago, Ill.

The last meeting of the Board of Managers of the Alumni Association was held March 5, and at this meeting several matters of importance were brought up. It was suggested that the election of officers for the coming year be held in a different manner than heretofore, with a view toward obtaining stronger opposition to the slate presented by the Nominating Committee and hence a more spirited contest for the various offices. Several plans are under advisement by the Board and it is possible that there may be a good field for some engineer-politicians at the spring meeting.

Preliminary arrangements for the spring meeting were discussed, it being deemed wise to have an early start toward making one of the most rousing reunions yet to be held. Further announcement of plans for this meeting will be made in the next issue. The Association remains on a very sound financial basis, thanks to loyal alumni, but the movement to hold a quarter-

century celebration of the founding of our Alma Mater has instilled in the Board of Managers an ambition to accumulate sufficient additional funds for the purpose of properly carrying out the plans for the celebration. It is the intention of the Board to set aside for this purpose as large a sum of money as can be spared each year during the coming three years. May these good intentions be realized.

THE TWENTY-FIFTH ANNIVERSARY CELEBRATION OF THE FOUNDING OF ARMOUR INSTITUTE OF TECHNOLOGY

Announcement was made in the November, 1914, issue of this magazine that tentative plans for holding a monster reunion and celebration in 1917 were being discussed by the Board of Managers of the Armour Alumni Association. It was proposed to celebrate the twentieth anniversary of the first graduation at the Armour Institute of Technology, the affair to be held in conjunction with the faculty.

A committee was appointed in September for the purpose of drawing up a set of plans for such a celebration and to make its recommendations to the Board of Managers. The committee is composed of E. O. Griffenhagen, chairman, H. W. Clausen and Fritz Lindberg, and the subject of its assignment has been given much deliberation. The general conclusions reached are given in the following matter.

It was recommended that the time of the celebration be changed from the year 1917 to the year 1918, which will be the twenty-fifth anniversary of the founding of the Institute. After some discussion this recommendation met with the approval of the Board of Managers. It is believed that all alumni will also voice their approval of this change in plans, since the occasion of the twenty-fifth anniversary of the Institute is one which is even more worthy of celebration than the twentieth anniversary of the first graduation. In addition, the former occasion will appeal more strongly to the alumni as a whole, as well as to the faculty and student body at the Institute.

The committee suggested that the affair should cover at least two days' time and should include events of various kinds. They

gave much discussion to the possibilities and details of such a program, but deemed it unwise to announce any definite plans at the present time, believing that these matters should be the subject of further deliberation on the part of the permanent committee recommended below. It may be said that is was suggested that the program include a day meeting at the Institute, a banquet downtown attended by prominent speakers, a theater party *en masse* (the entire house to be chartered), social and fraternal receptions, athletic events, a dance and other functions.

An event of this character will necessitate greater administration than the usual semi-annual meetings held by the Association, and in order to provide an adequate controlling body the committee suggested that a permanent organization be created immediately so that the next three years can be utilized in making the necessary arrangements. The plan recommended is the establishment of a growing committee to consist of three members to be appointed by the 1914-15 Board and hold office until June, 1918, and three additional members to be chosen during each succeeding year until the total membership of the Celebration Committee so formed has reached twelve. It is proposed to let the committee choose its own chairman, secretary and treasurer, and it is further proposed to turn over such sums of money as the Board of Managers may appropriate each year to the committee for it to invest and ultimately use. It will also be within the committee's power to accept subscriptions from those who desire to participate in the events.

The committee spent a great deal of time estimating the cost of such a celebration but did not arrive at any definite figure. However, it suggested that a rate for each coupon ticket be fixed to cover the expense of all events; that subscriptions be asked in the very near future, and that the entire coupon ticket be paid for in small yearly installments. It was recommended that there be no further expense on the part of those participating in the affair, and that all of the receipts from the sale of tickets as well as the appropriation by the Board of Managers be expended in connection with the anniversary celebration.

The Board of Managers received the report of the committee and all of its recommendations were approved. The committee

having displayed such an active interest in their duties, a motion was made and carried placing them on the permanent Celebration Committee, where it is assured they will do much toward making the twenty-fifth anniversary a most successful event.

ALUMNI NOTES

Ernest L. Wallace, class of 1902, has resigned as assistant examiner in the United States Patent Office and has accepted a position as assistant to Edmund A. Strause, a patent attorney of Los Angeles, Cal., where he is now located. His address is 639 Wesley Roberts Bldg. Mr. Wallace is a graduate of the law department of Georgetown University and is a member of the bar in the District of Columbia. He expects to become a member of the California bar at an early date.

With sincere regret do we make mention of the demise of Winfield Peck, '12, which occurred Feb. 24, 1915, at the family residence, 2254 Michigan avenue, after a brief illness. Winfield Peck was the son of Mr. and Mrs. Clarence I. Peck and was born June 24, 1899, at Oconomowoc, Wis.

Dr. Gunsaulus conducted the funeral services and in eulogizing the deceased said: "He was one of the most wonderful young men and his death cut short a career of extraordinary promise. While in Armour Institute he made special studies in electrical engineering and became a master of the subject. Since he was graduated he devoted his energies to special research in a workshop he fiitted up at his home, and he made many deep experiments getting at the basis of scientific theories. He became well known in his special field and was consulted by many high authorities. At the time of his death he was preparing as an expert on phases of patent law relating to electrical inventions."

Extracts from a letter received from E. W. Adams, '08, follow: "I am writing this to request you to change my address on your records to Assistant Patent Counsel, Western Electric Co., Ltd., 53-54 Chancery Lane, London, England. You will be interested to know that at least one Armourite was on the ground when the present war started. I had been located at Antwerp for about a year, holding the position of Assistant European Counsel for the

Western Electric Co., and allied companies. I left Antwerp with numerous other refugees and fled to England, leaving all my household goods in Antwerp. During the bombardment of that city the house was struck by a shell, but no material damage resulted. I hope to find time to write you giving the details of my experiences as a war refugee." We hope Mr. Adams finds time, for there is promise of a very interesting account of his experiences.

Stanley Dean, '05, Recording Secretary of the Alumni Association, has just completed the compilation of a roster of graduates, corrected up to date. The percentage of unknown and incorrect addresses has been materially decreased, due greatly to Mr. Dean's efforts. It may be said in passing that he proudly acknowledges the fact that a baby daughter arrived at his home recently.

J. T. Fieldseth has accepted an appointment in the United States Reclamation Service and is now at Provo, Nev.

E. O. Griffenhagen, '06, betrayed his neutrality recently when he announced that a wee prospective Teutonic nurse had arrived at his home.

R. A. Wight, 07, was recently blessed with an infant daughter.

Charles Kopald, class of 1913, who spent nearly a year working as electrical engineer at the Panama Canal, has returned to Chicago and is now working for Commonwealth Edison Co.

The following personal item was clipped from a recent issue of the *Electrical World*: Arthur J. Cole, who resigned as district manager of the Westinghouse Lamp Company of Chicago Jan. 23, 1915, has taken a substantial financial interest in the McGraw Company, operating electrical and mill-supply jobbing houses at Sioux City and Omaha, and will become its vice-president and general sales manager. Mr. Cole was born in London, England, in 1882, and spent the early years of his life and secured his grade and high-school education in Ottawa, Ill. He spent a period of about three years in Montana in search of health and on returning to Ottawa completed his high-school education. In 1903 he entered Armour Institute, Chicago, taking up the study of electrical engineering. Shortly after leaving Armour Insti-

tute he entered the employ of Kohler Brothers, prominent electrical engineers and contractors in Chicago, as a clerk in the switchboard department. During his several years' connection with this concern he was successively manager of the different departments, and at the time of his resignation from that company he was sales manager. Upon his resignation from the firm of Kohler Brothers he was appointed district manager of the Westinghouse Lamp Company in charge of the Central West district, with main office at Chicago and sub-offices at Milwaukee Minneapolis, Omaha and Kansas City, and in this connection he became very well acquainted with the large central-station and jobbing interests. In his new position with the McGraw Company Mr. Cole's technical and general electrical experience, gained during his connection with Kohler Brothers, combined with the merchandising experience gained while in charge of the Westinghouse Lamp Company's interests in the Central West, should be of great service."

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THE FORESTS OF THE UNITED STATES

BY LEONARD LUNDGREN*

GENERAL

Foreword.

The information contained in this article has been secured from government publications, and from written reports on file with the United States Forest Service. No originality is claimed by the writer other than the form in which the matter is presented. Quotation marks should have been used extensively, but have been omitted to increase the readability of the subject matter. The work of the Forest Service is so varied that it will not be described except in a general way.

Amount and Ownership.

The amount of standing timber in the United States totals approximately 2,900 billion board feet. Seventy-six per cent of this, or 2,200 billion board feet, is privately owned. About twenty-one per cent, or 600 billion board feet, is within the boundaries of the National Forests, and three per cent, or ninety billion board feet, is on other public lands, either federal, state or municipal.

The original stand of timber in the United States has been roughly estimated at 5,200 billion board feet, covering an area of approximately 800 million acres. Fire has destroyed as much timber as has been utilized for industrial purposes, and as much again has been wasted thru poor logging and milling operations and thru clearing land for agricultural purposes.

Location.

Almost five-elevenths (1,300 billion board feet) of the standing timber in the United States is located in the Pacific Northwest (Washington, Oregon, Idaho and Northern California), where

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the chief trees are Douglas fir, western red cedar, western white and yellow pine, western hemlock, sugar pine, western larch, and redwood. About one-fourth (720 billion board feet) is located in the southern pine region (Louisiana, Mississippi, Arkansas, Florida, Texas, Alabama and parts of Georgia, North Carolina, South Carolina, Virginia, and Missouri), where the principal trees are longleaf, shortleaf and loblolly pine (all marketed under the name of yellow pine), cypress and gum, oak and other hardwoods. The Lake States contain perhaps 100 billion board feet of timber, mostly white, Jack and Norway pine, hemlock, balsam, birch, beech and maple. The Northeastern States are the chief source of supply for spruce, which is used largely in the manufacture of paper.

Annual Cut.

The annual cut of saw timber in the United States is approximately forty-three billion board feet. At this rate, if there were no new growth, our present timber supply would last about sixty-five years. The Pacific Northwest now furnishes only one-sixth of the annual cut, tho it contains practically one-half of the standing timber in the United States. The southern pine region is now the center of the lumber industry, supplying about forty-five per cent of the timber consumed. The Lake States supply only a small percentage, altho this region, because of cheap transportation to market, was once the center of the lumber trade. In 1912 the chief lumber producing states, in the order of their importance, were: Washington, Louisiana, Mississippi, North Carolina, Oregon, Texas, Arkansas, Virginia, Wisconsin, Michigan, Minnesota, Alabama, West Virginia, California and Florida. Yellow pine furnishes more than thirty-seven per cent of the lumber used and Douglas fir more than thirteen per cent. Washington supplies the most Douglas fir and western red cedar; Louisiana, the most yellow pine, tupelo and cypress; Mississippi, the most cottonwood; Arkansas, the most hickory and red gum; Wisconsin, the most basswood, birch, and hemlock; Michigan, the most beech, elm, and maple; Minnesota, the most white pine, and West Virginia the most oak, yellow poplar and chestnut.

The people of the United States use, in a normal year, about 40 billion board feet of lumber, 90 million cords of firewood, 135 million hewn railroad ties, 30 million sawed railroad ties, 889

million posts, 3½ million telegraph and telephone poles, 1,686 million staves, 136 million sets of heading, 353 million barrel hoops, 3,300,000 cords of pulp wood, 165 million cubic feet of round mine timbers, and 1,250,000 cords of wood for distillation.

The annual growth of wood in the forests of the United States has been estimated to average approximately twelve cubic feet per acre. The annual consumption, considering the present forest area, is thirty-six cubic feet per acre. The forests of the United States are, therefore, being harvested three times as fast as they grow.

Future Supply.

Owing to the increase of population it is reasonable to expect that all agricultural lands, cultivated or uncultivated, will ultimately be placed under crops that will give the greatest economic return. Some of the lands that are now being cultivated for food and forage crops will unquestionably be returned to forest. Large areas that are now in forest will unquestionably be brought under cultivation. Forestry experts have estimated that the amount of land devoted to the cultivation of timber will decrease from its present area of 550 million acres to approximately 450 million acres, or, assuming a population of 150 million, to three acres for every inhabitant. To maintain our present per capita consumption of 260 cubic feet of wood there would have to be over twenty-one acres of land reserved for forest purposes for every inhabitant, or more than seven times the probable future area of forest land in the United States. The present forest area is less than eight acres for every inhabitant. The needs of the people today are supplied because the forest contain a virgin stand of timber which represents the accumulated growth of centuries. For this reason it is difficult for the average person to conceive of the conditions that will exist in the future when our timber crop is harvested in a manner similar to other agricultural crops. In fact, very few people think of timber as being an agricultural crop.

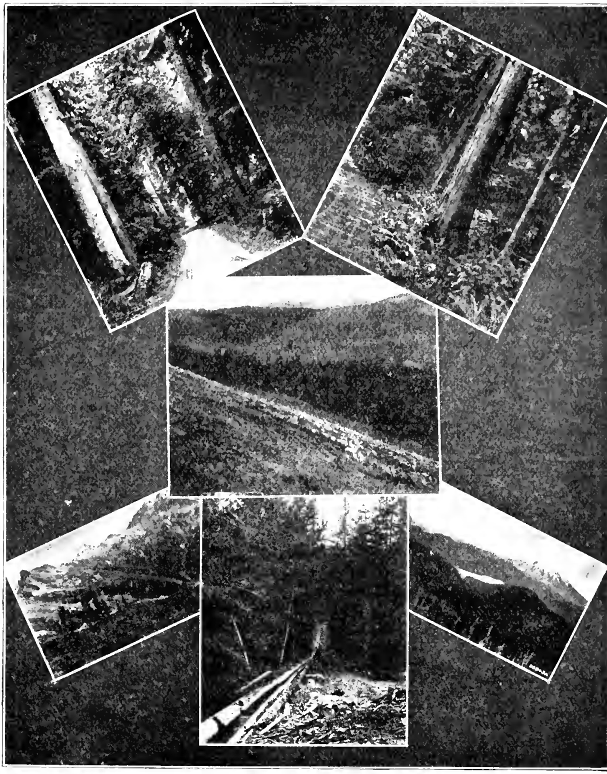
The constantly decreasing area of virgin timber will gradually compel an economical use of wood. As it becomes more expensive, the growing of timber as an agricultural crop will become commercially feasible. This has been demonstrated under the existing economic conditions in Germany. Thru reducing

the per capita consumption, protecting the forests from fire, and increasing the annual growth per acre by the practise of forestry, a balance between production and consumption will eventually be reached by the force of natural economic laws. Greater efficiency in the use of wood will materially reduce the annual per capita consumption, which at present is 260 cubic feet. In fact, the use of concrete and fireproofing materials has already effected a reduction in the per capita consumption. Under existing manufacturing conditions, only fifty per cent of the volume of the tree is now utilized, leaving half to be wasted. Forest fires destroy, on an average, twelve billion board feet of timber annually. Scientific fire protection will, without doubt, considerably lower this average, making the quantity saved from fire available for beneficial use. The aim of the science of forestry is to bring the forest up to its highest state of productiveness and keep it there. In the United States, where forestry is not practised except on Government and State lands, and there only during the last few years, the estimated annual production is, as stated previously, twelve cubic feet per acre. In Saxony, where forestry has been practised for many years, the annual production is ninety-three cubic feet per acre. If our final forest area of 450 millian acres is made to yield an average of fifty cubic feet per acre, as can be done by the practise of scientific methods, there would be enough wood for a per capita consumption of 150 cubic feet by 150 million people.

NATIONAL FORESTS

Location.

The public lands of the United States reserved by the Federal Government for forestry purposes are now divided, for administrative purposes, into 153 National Forests. Due to the comparatively recent development of the conservation movement and the fact that the public lands owned by the Federal Government are located principally in the West, most of the National Forests are located in that region. Congress, however, has been appropriating for several years two million dollars annually for the purpose of purchasing lands in the East, in order to more evenly distribute areas reserved for growing forests. There are seventeen National Forests in the State of California, fifteen in Ore-



1. Road thru Virgin Forest near Ashford, Washington. 2. Virgin Stand of Red Cedar in Washington. Note the Luxuriant Undergrowth. 3. The Rocky Mountains in Colorado, Showing a Thousand Sheep Grazing in the Holy Cross National Forest. 4. View of the Cascade Mountains in the Columbia National Forest, Washington. 5. The Cascade Mountains in Washington Looking South, Showing Mt. St. Helens and Spirit Lake. 6. Log Slide in the Kaniksu National Forest, Idaho, Showing Second Growth Timber.

gon, eleven in Washington, two in Alaska, seven in Nevada, nineteen in Idaho, eleven in Utah, ten in Arizona, seven in New Mexico, seventeen in Montana, eight in Wyoming, seventeen in Colorado, one in North Dakota, three in South Dakota, one in Nebraska, two in Arkansas, one in Oklahoma, two in Minnesota, one in Michigan, and one in Florida. In addition, there are sixteen purchase areas located in the Allegany Mountains, distributed as follows: Two in Georgia, four in North Carolina, five in Virginia, one in West Virginia, three in Tennessee, one in New Hampshire. The total area of National forest land is 163 million acres, equalling that of the New England States and New York, Pennsylvania, Delaware, Maryland and Virginia combined. In addition, there are contained within National Forest boundaries approximately twenty-one million acres that have passed from the control of the Federal Government either to the States or to private interests. The average area of public land reserved in a National Forest is slightly over 1,060,000 acres. The unreserved public lands of the United States totaled 666,000,000 acres in 1914.

Purpose.

The National Forests are set apart to insure a perpetual supply of timber for the use and necessities of the people of the United States, and to prevent destruction of the forest cover, which regulates the flow of streams. It has been found that on denuded watersheds the stream flow is less uniform than on forested areas, and more rapid erosion of soil takes place. The final results of deforestation are barren mountain sides incapable of supporting vegetable growth, and flooded lowlands.

Resources.

The National Forests contain approximately 600 billion board feet of merchantable timber worth at least one billion dollars. The other resources, such as grazing, water supply, water power, irrigation, etc., are worth probably more than a billion dollars, bringing the total value up to over two billion dollars. At the present time they contain 1,175 watersheds that supply water to as many cities and town for domestic purposes; 324 water power and 1,266 irrigation projects developed or in the course of development.

Administration.

The Forest Service of the Department of Agriculture administers the National Forests. During 1914 a permanent force of over thirty-seven hundred men was employed to protect these forests from fire and other destructive agencies, to build roads, trails, telephone lines, bridges, and other works to make them accessible; to conduct the sale and oversee the cutting of mature timber in accordance with the principles of forestry; to regulate the grazing of livestock in order to improve the range; to protect the settler and home builder from unfair competition in its use; to issue permits for the development of its water power resources and for the construction of hotels, dwellings, stores, factories, telephone lines, conduits, public roads, reservoirs, etc. It is the purpose of the Forest Service to encourage the development of the resources of the National Forests. The timber, water and pasture are for the use of the people, and minerals are open to development just as on unreserved public land.

Use.

The timber cut on the National Forests shows a substantial increase annually. In 1914 the cut, under sales, totaled 626 million board feet as compared with 495 million board feet in 1913, an increase of twenty-six per cent. The value of the timber cut was $1,271,000 as compared with $1,075,00 in the former year. Every effort consistent with sound management was made to increase the volume of sales. Desirable blocks of timber were appraised, placed upon the market and widely advertised. The terms offered have been as liberal as proper regard for the public interests would permit. Sacrifices in prices below the market value of the stumpage, as appraised by competent logging engineers, have not been considered, as such action would be contrary to sound business policy. The reason why more sales could not be made does not lie in the question of price, but is due to the inaccessibility of the National Forest timber compared with the forests under private ownership. The increase in small sales has been marked. The total number of sales during 1914 was 8,298 as compared with 6,182 in 1913. This indicates more general use of the National Forests for the supply of local needs, and an increase in the kind of sales business which the Forest Service is most anxious to develop. The average

stumpage price obtained in commercial sales during 1914 was $2.32 per M board feet, an increase of twenty-two cents over 1913. On the Florida National Forest the timber now yields its chief revenue thru turpentining operations, which brought in $13,372 during 1914.

There has been a significant increase in the amount of timber sold at cost to homestead settlers and farmers under the Act of August 10, 1912. 14,207,000 board feet was sold in 1914 as against 718,000 board feet sold during the preceding year. Under the regulations established by the Secretary of Agriculture, the homestead settlers and farmers on the National Forests and in their vicinity obtained this timber at an average cost of seventy cents per thousand feet.

The free use of National Forest timber for domestic purposes by settlers, local residents, and prospectors, varies but little from year to year, from 35,000 to 40,000 permits being issued annually for this use. Of the total amount taken, 31,826,000 board feet are live timber and 88,749,000 dead, with respective values of $85,160 and $98,060.

More than 1,620,000 cattle, horses and swine, and 7,620,000 sheep and goats were grazed within the National Forests under permit by 29,000 stockmen in 1914. Under scientific management, the forage crop on National Forest lands is markedly improving in condition, productivity, and grazing value. The number of animals authorized to graze on the National Forests by the Secretary of Agriculture is increasing annually. The latest authorization totals 1,891,000 cattle and horses, 66,000 hogs, and 8,868,000 sheep and goats. Range conditions within the National Forests are being studies by experts, not only to increase the quantity of forage crops, but to make the ranges accessible to the stock. Systems of roads, trails, and drift fences are being extended annually, additional sources of water supply are being developed, and added protection is being afforded against losses thru poisonous plants, predatory animals and other agencies which tend to prevent the use of much good range land. Gains secured in this manner will not continue indefinitely, but no limit can as yet be set to the possibilities of increasing the present carrying capacity of forest lands thru better methods of management and use, supplemented, perhaps, by judicious seeding.

Ninety-two hydro-electric power plants, eight hundred hotels, rest houses and summer resorts, and fourteen hundred stores and other business buildings are now operating on the National Forests under permit. Seventeen hundred mining claims were patented during the past year within the National Forests, where the total mining population is more than twenty-four thousand. Twenty thousand permanent settlers occupy farms within the National Forest boundaries, one and a half million campers, hunters, fishermen and other pleasure seekers used the National Forests as recreation grounds during 1914.

Protection and Improvements.

The Forest Service extinguished 4,520 forest fires during the calendar year 1913. Half of these fires burned over less than a quarter acre before they were put out. The development of an efficient fire department is progressing rapidly. The experience secured each year enables the Forest Service to improve its organization for the next year's work. As the funds apppropriated by Congress are small, when the great areas administered are considered, it can be appreciated that several years will be required before the fire-fighting system on the National Forests is fully developed.

Forest officers during the fiscal year 1914 killed 4,135 predatory animals, including mountain lions, coyotes, and wolves, in order to protect stock grazed on the National Forests. The wolf and coyote, the two species that do by far the greatest amount of damage to game and domestic stock, frequent the National Forests only during the months when game and domestic animals are most abundant. They are bred, born, and spend the major portion of their life cycle in the foothills and flats outside of the forests. Under these conditions the animals killed on the forests are replaced by others from the outside ranges, and this will continue to be the case until the Government initiates a general movement to destroy them throughout the length and breadth of the United States.

Poisoning operations against prairie dogs were conducted by the Government upon a number of National Forests, with excellent results. There is little likelihood that the dogs will reestablish themselves within the areas treated. The funds appropriated by Congress for this purpose are far too limited to meet

the needs of the National Forests, to say nothing of the demands for similar work on other public lands. It would be economically advantageous for the Government to destroy systematically every prairie dog town now occupying public lands, for the ultimate increase in grazing capacity would more than return the cost of the work.

Fire Tool Box, U. S. Forest Service. Thousands of These Boxes are Scattered Thruout the National Forests.

During the past year, 30,000 acres were sown or planted to young trees, making a total of 117,000 acres planted or sown on the National Forests to date.

The permanent improvement appropriation for the year 1914 was $400,000 and was employed for both new construction and maintenance. This fund was largely supplemented by odd-time labor of the regular Forest force. Besides repairing lines of communication and other permanent improvements damaged by winter storms, 270 miles of new road, 21,153 miles of trail, 3,063 miles of telephone line, 775 miles of fire line, and 106 fire lookout structures were built. Additional roads built by the use of the ten per cent road fund, derived from National Forest receipts, brought the total road construction for the year to 642 miles. There were also constructed 118 bridges, 461 dwellings, barns

and other structures, 19 corrals, 360 miles of fence, and 186 water improvement projects. The estimated value of all improvements on the National Forests at the end of the fiscal year 1914 was slightly over $4,500,000. More than 2,600 miles of road, 1,500 miles of fire line, 18,000 miles of telephone line and 18,000 miles of trail have been built on the National Forests since they were transferred to the administration of the Department of Agriculture in 1905.

Revenues.

During the fiscal year 1914 the revenues of the National Forests were approximately $2,500,000. Of this, $1,300,000 was from timber sales, $1,000,000 from grazing fees, and the balance from rentals charged for water power and special use permits. Twenty-five per cent of these receipts is paid to the State in which the revenue is collected, to be used for road and school purposes. In addition, ten per cent is expended by the Forest Service in the State where the money is collected, for road construction within the National Forests.

Disbursements.

During the fiscal year 1914 the expenditures by the Forest Service totaled $5,735,000. Of this $3,252,000 was spent for administration and fire protection, $980,000 for improvements, $1,200,000 for inspection, etc., $302,000 for forest investigations. It is expected that the disbursements of the Forest Service will remain constant in the future but that the receipts will increase rapidly as the National Forests become more accessible and as the private holdings of timber decrease in quantity. Congress makes appropriations for all of the expenses of the Forest Service.

STATE FORESTS

The fourteen States which have set aside forest reserves of their own, with an aggregate area of 3,400,000 acres, are California, Connecticut, Indiana, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, South Dakota, Vermont, and Wisconsin. Thirteen states maintain nurseries which produce each year about ten million small trees, one-half of which are planted in the State Forests and one-half sold to private owners at cost.

Pennsylvania has 983,529 acres of State forests, has planted to

date 2,800 acres with young trees, produces 2,500,000 forest tree seedlings from its nurseries every year, has a number of State experiment stations, and makes an annual appropriation for forestry of about $328,000.

New York has 1,664,000 acres of State forects, has planted to date 7,000 acres, produces 4,500,000 young trees yearly, has established a State forest experiment station, and makes an annual appropriation for forestry of about $190,000.

Massachusetts has 15,000 acres of State forests and fifty-six separate municipal forests. Each year it produces from its nurseries upward of 1,300,000 young trees. The annual appropriation for forestry amounts to about $55,000.

Minnesota has 43,000 acres of State forests, and makes an annual appropriation for forestry of about $233,000. Citizens of the State have planted 250,000 acres of their lands with trees.

Wisconsin has 400,000 acres of State forests, and makes an annual appropriation of $95,000 for forestry.

FOREST FIRES

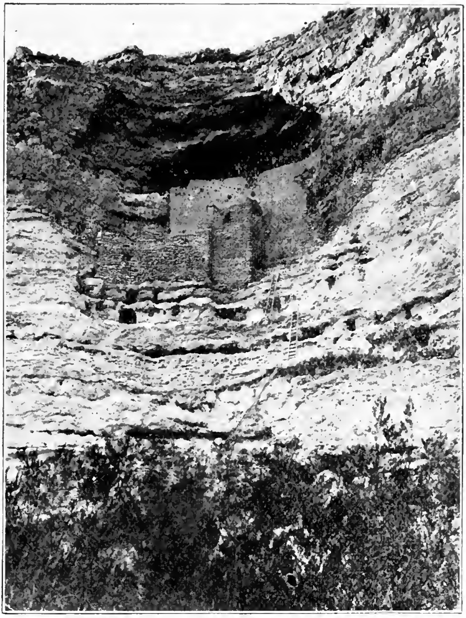
Losses.

Forest fires in the United States have destroyed, on an average, each year, at least twenty-five million dollars worth of timber and have caused, in addition, great losses in stock, crops, buildings and other improvements. In the past fifty years more than 3,000 persons have been burned to death in forest fires. The Peschtigo, Wisconsin, fire in 1871 burned over 1,280,000 acres and cost 1,500 human lives. The Hinckley, Minnesota, fire of 1894 burned over 160,000 acres, with a death list of 418. The great Idaho, Montana and Minnesota fires of 1910 swept 2,300,000 acres and burned to death 127 persons. Every fire that starts in a forest may develop into a serious conflagration. All that is needed is dry weather and a strong wind. In the State of Michigan alone forest fires during the ten years between 1901 and 1911 caused a loss of twenty million dollars. In Massachusetts forest fires from 1910 to 1913 have caused a damage of over $800,000. Forest fires are unnecessary and may destroy in a short period what nature has taken hundreds of years to create. Investigation has found that fires are nearly always the result of carelessness. The desolation caused by a forest fire can only be appreciated by those who have inspected a forest area

before and after it has occurred.

Causes.

The three chief causes of forest fires are found to be railroads, campers and lightning. These causes are responsible for more than one-half the fires that start. Sparks from the smokestack and live coals from the firebox are responsible for the fires that



Ruins of Cliff Dwellers in the Coconino National Forest, Arizona. Known as Montezuma Castle.

start along railroad rights of way. Hunters, pleasure-seekers and others leave camp fires buring or throw lighted matches or tobacco into inflammable material.

Protection.

The Federal Government, twenty of the States and thirty timber owner's associations maintain systems of patrol and take

other preventive measures on their lands during the fire season. The area protected by the Government is approximately 184 million acres; that protected by States (largely in co-operation with the Government, as provided by the Weeks Law) 100 million acres, and that protected by the timber owners' associations, twenty-five million acres.

The area now under some form of fire protection is slightly over half of the area of forest lands in the United States. This shows a wonderful advance in the last few years, but every effort should be made to secure fire protection for the entire forest area. As a result of these protective agencies the loss from fire is being considerably reduced.

SIGNALING FOR INTERURBAN ELECTRIC RAILWAYS

BY J. E. SAUNDERS*

There is no great variation in practice between steam and electric lines insofar as the signaling for interlockings protecting grade crossings in concerned, except that complete protection has not always been provided on electric lines, but there is a considerable difference in both apparatus and its application in case of automatic block signaling.

Track circuits are used universally for automatic protection of trains propelled by steam and will ultimately have as general application on roads where electric propulsion is used, but have not been so widely applied on the latter, principally on account of their relatively greater cost. A track circuit as used in railway signaling is a section of track, the rails of which are electrically insulated insofar as signaling currents are concerned, from the rails of adjoining sections. On steam lines the insolation of a section may be complete, but on electric lines the continuity of the return path for propulsion current must be maintained, and yet the section practically isolated for signaling purposes. Primary or storage battery may be used for the supply of power in a track circuit on a steam line, but the application of direct current to track circuits where the rails must also carry return propulsion current has not been extensive, although it has proven satisfactory on some short track circuits, even under heavy traffic conditions.

Alternating current has been used much more extensively than has direct, for signaling electric railways, and it is this that will be discussed, with particular stress upon its application to high speed interurban electric railways. The track circuit is fed by a transformer, through an impedance, or by a special transformer which will not be injured if subjected to short circuit. The two rails form the conductors for the signaling track circuit, and are in series with the relay, which is located at the end of the track circuit opposite the transformer, or in case of center-fed track circuits, one relay is located at each end of

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the circuit, with the transformer connected to the rails midway between these. A typical track circuit is shown in Figure 1. The function of the impedance bonds will be described later.

Trolley contactors, with counting in and out devices are used to some extent for automatic signaling, but are limited in their

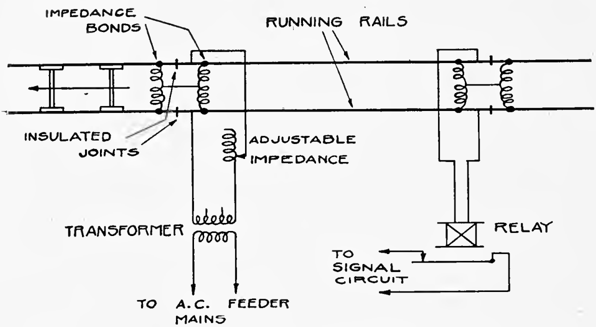

Fig. 1. Typical Alternating Current Track Circuit for Electric Line.

application because they do not afford continuous protection, and are subject to failures, due to trolleys leaving the wire, which permit trains to receive false clear signal indications. Trippe arms located on the ties may serve the same purpose as trolley contactors, and have most of the disadvantages of the latter, with additional ones due to snow and sleet conditions. Ramps are also used to a limited extent. Either tripper arms or ramps may be made to work in conjunction with devices for automatic train control. The logical requirement when safety is paramount, is complete protection and this can be secured only through the medium of track circuits.

Two types of signals are commonly used: semaphore and "Light." The semaphore signal consists of one or more blades, supported by a vertical mast. The mast may either rest on a foundation in the ground or on a signal bridge. The blade is ordinarily located above the point of support for the mast, but may be below this, in case of suspended signals. On account of pole lines interfering with the view if signal arms or blades extend to the right of the mast, common practice on interurban electric railways has been to present the signal aspect in the

upper left hand quadrant, which brings the blade to the left of the mast. The horizontal position of the arm or blade indicates "Stop," sometimes without, and at times with certain limitations, these being prescribed by the railway lines concerned. A blade inclined at an angle of either 45 or 60 degrees above the horizontal, i. e. to within 45 or 30 degrees from the center line of the mast, indicates "Proceed," also at times under certain restrictions. Where the view is not obstructed by pole lines signals presenting aspects in the lower or upper right hand quadrant may be installed. Signals of this kind are shown in Figure 2.

By "Light Signal" is ordinarily meant the type of signal which gives only color or position light indications, by day as well as by night. Semaphore signals make use of colored light for conveying information at night, but no attempt is made to have this replace the day time aspects of this type of signal. The light signal is peculiarly adapted to many interurban electric railway installations, because energy is available for electric lighting and because of the high braking efficiencies of electric trains. The color light signals indicate "Stop" by showing red light, "Proceed" by green and "Caution" or "Proceed under Control" by yellow. This is true for both the day and night light signal and the night indications of the semaphore type signal.

The number of signals required to protect a given length of track, and to provide for satisfactory handling of traffic, will depend upon the minimum headway to be maintained, and the braking efficiency of the rolling stock handled. On some single track lines, blocking from station to station is considered sufficient; on the other hand a double track installation is being made at this time, with most of the blocks of only 750 feet length. Between these two one may find a combination of signals to suit almost any prescribed condition. On some lines particularly on double track, one arm three-position signals, or signals with two two-position arms are provided so that a train may receive a "Stop" a "Caution" or a "Proceed" indication at each signal location. On other lines, particularly on single track, two position signals are used. These may indicate either "Stop" and "Proceed" or "Caution" and "Proceed."

The control for a three position signal on double track is quite simple. A train will hold the signal immediately behind it at

"Stop" and the second signal in the rear at "Caution" while the third signal in the rear may indicate "Proceed" if there is no train between it and the train referred to; thus one train may follow another and receive "Proceed" indications if two clear blocks intervene between the two, or one may follow the other under "Caution" indications with one block intervening. A

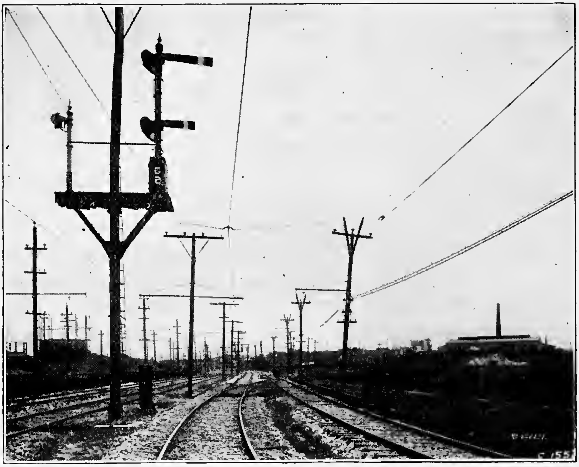

Fig. 2. Havana Central Ry. Gas Junction, near Havana, Cuba.

two-position signal on double track should have an overlap, as a single block control for such a signal is not safe.

In order to protect against "head-on" movements of trains on single track the controls must be overlapped and preliminary sections provided. This condition makes it necessary for trains to be spaced a considerable distance apart for following movements, and has resulted in the development of the "Traffic Direction Block" more familiarly known as the "T. D. B." system of control, which allows for following movements on single track, between sidings, but restricts "head-on" train operation. This control is secured by the proper arrangement of stick relays and circuits, and makes it possible to use a minimum amount of signal apparatus and at the same time secure maximum capacity

from the track signaled. This system can be seen in operation on any of the following railways:—Chicago, Lake Shore & South Bend; Indianapolis, Columbus & Southern Traction Co.; Chicago, South Bend and Northern Indiana; Louisville & Northern Railway & Lighting Co.; Ohio Electric; Scranton & Binghamton; Kansas City, Clay County & St. Joseph. On the Scranton & Binghamton where the T. D. B. system is in operation automatic signals have superseded dispatcher's control of train movements entirely. Ordinarily automatic signaling is an adjunct—made supplementary to dispatcher's control of train operation, and is considered more as a means for safeguarding and expediting traffic rather than as a substitute for the train order system.

At the intersection of two or more routes or lines an interlocking plant may be installed for the protection and control of interurban trains. The signals, switches and other ground apparatus may be operated either manually or by power. In either case the "interlocking" or central controlling machine requires an operator. This machine consists of a number of levers controlling or actuating the switches, derails, locks and signals, so interlocked that the movement of one must follow that of others in a predetermined order. By means of a plant controlled by such a machine an intersection of two or more railway lines, or a junction of two or more, may be protected and trains operated with minimum delay over the switches and tracks controlled.

The electro-pneumatic system has proven most successful for handling large plants and especially so where time is a factor in the manipulation of switches and signals. As a Chairman of the Block Signal and Train Control Board of the Interstate Commerce Commission said, " 'Saving Seconds Safely is one function of the signal system,' " and where this axiom is most keenly felt is where the electro-pneumatic system is supreme. Electric interlockings are quite frequently installed at points where mechanical plants cannot handle the situation and where compressed air is not available or for some other reason it is not practicable to install an electro-penumatic plant. Electro-mechanical plants, with pipe-connected switches and electric signals are a more recent innovation and are proving satisfactory

for installations of medium size The mechanical plant costs less to install, although possibly more to maintain (including renewal charges) than any of those before mentioned.

Quite a number of interlocking plants have been installed at the intersections of interurban and steam railway lines. These permit the trains on both lines normally to pass over the intersecting tracks without stopping. The leverman may also manipulate switches, enabling trains to pass from one track to another and to perform other switching operations with minimum delay. A photograph showing a part of the Gas Junction Interlocking of the Havana Central Railroad, near Havana, Cuba, is reproduced as Figure 2. The bracket signal shown is a two arm Style "B" electric signal. Two-position indications are given, the blades moving in the lower right-hand quadrant. The low signal, located on the ground to the right is known as a "dwarf signal" and is used for governing reverse-traffic or other slow speed train movements. Track circuits may or may not be carried through interlocking plants. Continuous protection makes it necessary that these be installed, although their installation is often made less difficult where slip switches are located within the interlocking plant, by the use of what are called "single rail" circuits.

Single rail track circuits are similar to that shown as Figure 1, with the impedance bonds and the two insulated joints in one rail removed. The rail without insulated joints then carries all of the return propulsion current not leaking from the rails, and is common to the signal track and return propulsion circuits. The excessive drop in this common rail, due to the doubling of the resistance for return propulsion current limits the application of this scheme to short blocks, except on lines where traffic as well as rolling stock is very light. It is necessary to connect resistors in series with track windings of both relay and transformer, and it may be necessary also to connect a reactor in multiple with the relay to protect this from damage due to the difference of potential between the two running rails tending to cause a flow of current through the relay windings.

The double rail track circuit is more commonly installed, as the full capacity of both running rails is provided for return propulsion current, and it is furthermore possible to tie two or more tracks together at alternate signal locations, by joining

the neutral points of the impedance bonds on the several tracks. The impedance bonds have a very low resistance but a relatively high inductance. The return propulsion current, if equally divided between the two running rails, will pass through the two halves of a single impedance bond to the neutral connection between the two single bonds, dividing half and half. This bond is so wound that the magneto-motive-force caused by the current

Fig. 3. Chicago, Lake Shore, and South Bend Ry., Kaiser Siding.

in one half of the bond will neutralize that caused by the current in the other half, with a resultant flux due to propulsion return of zero. This is true whether the propulsion current is direct or alternating. The bond is designed so as to take care of 20% unbalancing of return propulsion current. It is, therefore, able to offer impedance to the alternating current used for actuation of the track relay, and since this impedance must cause a difference in potential at its terminals, current is available for the relay.

The local signal circuit is controlled through contacts on the track relay which are closed when the relay is energized. A train or car running onto the track circuit shunts out the relay,

as the wheels and axels of the cars offer a path of much lower resistance than does the track winding of the relay. The signal is held clear by current passing through the local circuit described and the blade will therefore indicate "Stop" as soon as the relay is shunted out. Safety, being the keynote of railway signal service, demands that all signal apparatus return to the "Stop" position when de-energized, or when deranged for any reason. The force of gravity is utilized in furthering safe operation. Line circuits are fed from the transformer tap supplying the local signal circuits, usually at 110 volts.

The track circuit diagram shown as Figure 1 applies to both D. C. and A. C. propulsion, although the various pieces of apparatus used are not the same for these two systems, as will be explained later. An example of signaling on an alternating current railway may be noted by referring to Figure 3, which shows a double signal location at a spur, on the Chicago, Lake Shore & South Bend Railway, and on a direct current railway by referring to Figure 4, which shows a double signal location on the Washington, Baltimore & Annapolis Railway. The two single impedance bonds are shown quite clearly between the rails in the latter. On both of these lines the signals are Style B with the blades moving in the upper left hand quadrant.

Engineering and operating experience in signaling are essential to the proper laying out and installation of a signal system. The larger interurban electric railways employ Signal Engineers, and some of the smaller lines employ consulting Signal Engineers whenever any signals or interlocking are to be installed. The larger manufacturers of signal apparatus maintain corps of engineers who are versed in signaling as applied to interurban railways and are glad to co-operate with the railway officials both in the development of apparatus, and in its installation as well as in making the power estimates which help in the determination of the relative economy of various schemes.

Fortunately alternating current power is usually available at the main power plants and sub-stations supplying energy for the interurban railway. Trolley poles are also ready for the support of signal transmission wires. Most A. C. signaling in this country is at 60 cycles, although many installations at 25 cycles have been made. The signal transmission line is usually

2300 volts, single phase, as but very little two or three phase signal apparatus is in service on electric railways. Some lines of 4400 or 6600 volts are in service, but it is seldom necessary to go to as high potentials as these, as the signal load is very light and the distance between feeding points relatively short.

The line transformer installed at each single or double signal location may be either a standard 2200 to 110 volt oil cooled transformer, generally of the lowest standard capacity, or a combined

Fig. 4. Washington, Baltimore and Annapolis Ry. Double Signal Location.

line and track transformer, with two or more secondary windings, to take care of all voltage requirements at a given location. If the standard transformer with a single secondary winding is used an auxiliary track transformer is required for stepping down from 110 volts to the voltage range (2 to 20) required under the leakage and track impedance conditions existing on the railway signaled. The track transformer may be of as low a rating as 50 V. A. or as high as 500 V. A. It may be of constant potential for use with an impedance coil, or of the reactive type with which an impedance coil is not required. The more flexible arrangement is the use of separate track and line trans-

formers, and this method also keeps losses at a minimum. The relation of track transformer secondary potentials to the potential it is necessary to impress upon the rails opposite the transformer must be given careful consideration as the shunting efficiency of the car axels and wheels depends upon their ratio. The lightning arresters and fused cutouts used in connection with the transformers connected to the transmission line are the

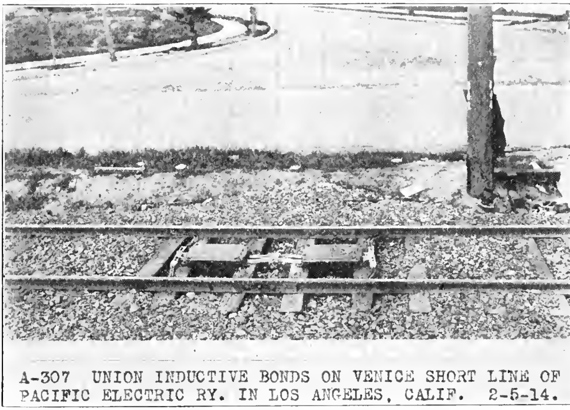

Fig. 5. Pacific Electric Ry. 500 Ampere Impedance Bonds.

standards adopted for other power line service at the same potentials and current capacities.

The impedance bonds which are used in connecting the opposite rails at the end of a track section, adjacent to the insulated rail joints, consist of a few turns of heavy copper or an iron core. These bonds range in current carrying capacity from 500 amperes per rail to 2000 amperes per rail for direct current propulsion, and from 50 amperes per rail to 200 amperes per rail for alternating current propulsion. The former are provided with air gaps in their magnetic circuits to increase the unbalancing necessary to saturate the iron. These bonds will ordinarily stand 20% unbalancing without materially reducing the impedance to alternating current. The impedance at 60 cycles ranges from .4 ohm to 1.0 ohm in case of bonds for D. C. lines, and

from 3 ohms to 20 ohms for A. C. lines. Two 500 ampere impedance bonds, connected to the rails and with their neutral taps tied together are shown in Figure 5. This installation is on the Venice Short Line of the Pacific Electric Railway, Los Angeles, California. The two ordinary rail joints shown in this plate were replaced by insulated joints before the bonds were placed in service.

The track relays used on railways, the cars of which are propelled by direct current, are of the Vane, Galvanometer, or Polyphase type. The Vane relay consists of an aluminum or copper segment mounted on a shaft which operates in jewel bearings, moving in a magnetic field produced by energized coils mounted on laminated iron cores, and which drives a contact shaft to which are connected contact fingers which engage blocks in either the energized or de-energized positions of the moving elements. This type of relay is now made with either single or double elements.

The Galvanometer relay is similar to the ordinary electrodynamometer in action, movement of the armature being caused by the action of the field produced by current in one coil upon that produced by current in another. This relay has two distinct windings or elements, one forming the armature and the other the field. The polyphase relay is virtually an induction motor, with a copper or aluminum rotor. The stator has two windings, with reactance and resistance cut into these in such a way as to split the single phase supply. The rotor drives the contact segment through a pinion. Some of these two element relays work on as low power as .035 V. A. in the track element, with the local winding consuming 12 watts.

The track relays used on railways with alternating current propulsion are of the centrifugal or vane frequency type. The copper rotor of the former rotating in the field caused by current flowing in the stator windings, when the latter are fed from a 60 cycle source, causes centrifuge arms to lift, closing the contacts. This relay will not attain sufficient speed at 25 or even 30 cycles to close the contacts. In this way it is selective between the propulsion frequency, 25, and the signaling frequency, 60. The vane frequency relay selects between 25 to 60 cycles by the action of an aluminum vane moving within the fields of two

cores which have copper bands so placed as to make the relay operative on the higher frequency, but not on the lower.

What relay to apply to a given installation is determined only after a careful study and analysis of the conditions which must be met. Two relays of the galvanometer type are shown in service, on the shelves of a relay box in Figure 6. This photograph was taken on the Washington, Baltimore & Annapolis Ry. Lightning arresters for protection of these relays may be seen

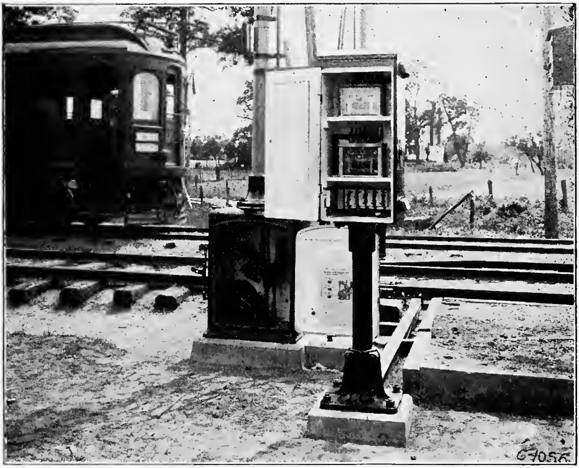

Fig. 6. Washington, Baltimore and Annapolis Ry. Style B Signal Mechanism and Galvanometer Relays.

mounted in the lower compartment of the relay box. Standard signal construction requires that the relay box be mounted either on an iron post resting upon a concrete foundation, as shown in Figure 6, or attached to a signal mast, as shown in Figure 7.

The mechanisms for operating the signal blades or arms may be located either at the base of the mast or closely adjacent to the spectacle and blade. The former methods simplifies maintenance and inspection while the latter places the mechanism nearer its load. The Style B signal, as installed on the W. B. & A. Ry. may be seen in Figure 6. This signal is known as the

slot arm type. The motor takes approximately 2 amperes at 110 volts, 60 cycles, when clearing the signal in 7 seconds. The slot requires .45 ampere to hold the signal clear. The mechanisms for the signals shown on Figure 7 are known as the T-2 type and are located near the blade. The signal at the right indicates "Stop," protecting the limited train which has just passed. The signal at the left indicates "Proceed under Control" or "Caution," for the light car which is just approaching.

Fig. 7. New York State Railways, Utica Park, Little Falls. T-2 Signals.

A single location of a Style B signal on the Illinois Traction System is shown as Figure 8. The impedance bonds, as well as the insulated switch rods and switch circuit controller are shown plainly in this illustration. The signal shown works in two positions only, and is indicating "Proceed."

Another type of signal which gives its indications by colored light during the daytime as well as at night is a two-way Model 13 light signal. Two 25 watt lamps are used behind each of the 8-3/8" doublet lenses in this signal. The colored light indications can be received at a distance of 1000 feet under

the most unfavorable conditions. Light signals using single 25 watt lamps, accurately based and aligned behind $10\frac{1}{2}''$ doublet lenses can be seen 2000 feet under the most unfavorable conditions, and at least 50% further in ordinary bright sunlight.

As intimated previously, the question of signaling and the

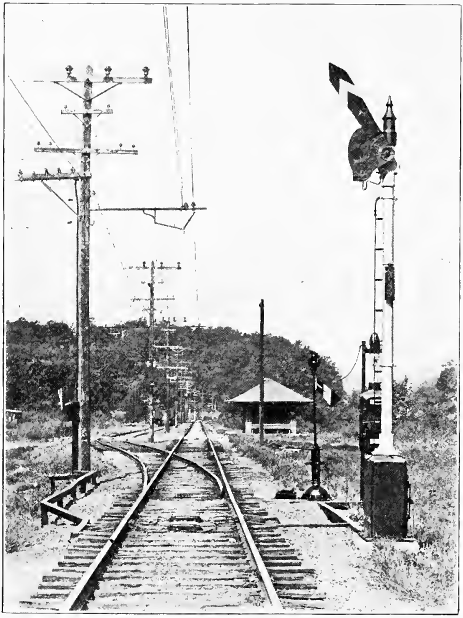

Fig. 8. Illinois Traction System. Style B Signal.

signal system to use for an interurban electric railway is very broad and not subject to a satisfactory solution without a complete analysis which includes an understanding of local conditions. When this information is available a signal system can be mapped out to fit any line and set of operating conditions, adding to the safety of travel and providing for more economical and expeditious operation of trains.

ENGINEERING FIELD PRACTICE, ARMOUR INSTITUTE OF TECHNOLOGY

History of the Various Encampments

BY A. E. PHILLIPS*

The Civil Engineering department of the Armour Institute of Technology was established in 1899. Even at that time the problem of providing opportunities for engineering field practice was a difficult one, and this work was carried out on Saturdays, weather permitting, in the Autumn and Spring terms. Even under the most favorable conditions we could not expect to have more than twelve good days all told for this work. The available spaces for work of this kind were to be gotten only after long rides into the suburbs, so that much time was lost going and represented only about 72 hours or nine days of effective time.

We visited Blue Island; the north shore north of Wilson Ave., at that time fairly open country; the Western City Limits; Jackson and Washington Parks. Each year the spaces available became more restricted as the population became more congested. coming with the result that the maximum of twelve days We had then to seek opportunities farther away from the city, with the consequent loss of time and effectiveness, or adopt the other alternative of establishing a Summer School in Surveying, providing continuous field practice during a proper interval. After mature deliberation it was decided to establish a Summer School in Surveying, the session to last through a period of six weeks; attendance at same and credit for the field practice, to be required of every graduate from the Civil Engineering department.

The proposed Summer School had much to commend it. Continuous, uninterrupted field practice would be an advantage to both instructors and students. In a proper location all counter-irritants would be eliminated and we might expect the maximum of results as soon as the plan was thoroughly organized and under way. Several of the Eastern engineering schools had already adopted such a plan, and it is only a matter of time until

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the Western schools in the more populous districts will do the same.

At the start we had no equipment aside from our instruments and we sought a place where living would be provided as well as the opportunity for field practice. This we found, or at least we thought we did, in Michigan, a short distance from Chicago. However, the "six hundred acres" available for field work, dwindled to one lot, 60'x200' and as to the living, we had a taste of life "in the trenches."

The second year we were more fortunate, as the session was held at Hamlin Lake, Michigan. We had better opportunities for field work and the living was as good as could be expected under the circumstances. However, we were hampered in our work, and we realized that a properly organized camp, in a favorable location, far from summer resorts was the only solution to the problem.

Thanks to the interest and enthusiasm of Mr. H. W. Jones of the class of 1911, we received during the winter of 1907, permission from the Menominee Boom and Lumber Company of Marinette, Wisconsin, to establish a permanent camp site upon the banks of the Menominee River, just outside of the city limits of Kremlin, Wisconsin. This offer was accepted and the Institute purchased an outfit of tents, cots, chairs, boats and a cooking and dining room outfit.

The first real "camp session" of the Summer School was held therefore at Kremlin, Wisconsin, during the summer of 1908. The field practice was as successful as might be expected for the first year, and the commissary department was an entire success both as to quality and quantity of food. The reduction in living cost was especially marked.

Profiting by experience, the attempt was made each successive year to systematize the field work and eliminate lost motion, until the session of 1912, when the entire field practice had developed to a fairly uniform system.

Meanwhile the Menominee Boom and Lumber Company had undergone a reorganization and conditions had developed that made it desirable to seek another and if possible, more permanent and desirable place for the Summer School camp.

It should be said right here, that in so far as field practice is

concerned, the Kremlin site was almost ideal. The country is rolling and the topography sufficiently diversified to offer all kinds of problems in surveying. However, the Menominee River is always dangerous and the instructors were always under nervous tension for fear of accidents. The tents were necessarily pitched in the open, offering no protection from violent wind storms or fróm the intense heat of the sun.

The problem of finding a new and desirable camp site was not an easy one, but by the merest accident, the writer's attention was directed to the work of the State Board of Forestry of Wisconsin and correspondence was had with Mr. E. M. Griffith, Chief Forester, and later a personal interview with Mr. Griffith at Madison, Wisconsin. A statement of our purposes and our problems met with hearty co-operation from Mr. Griffith and he offered to lease to the Institute, sufficient Forestry land for a camp site in return for instruction to be given to Ranger students in elementary field work during two weeks of the regular session. Our students were free to work over any or all of the lands under the State Board of Forestry involving practically two counties. It was suggested that the region around Little Tomahawk Lake, Wisconsin, would be adapted to our needs, and so the session of 1913 was held at Camp Armour, Little Tomahawk Lake. The camp site was certainly all that could be desired, but the opportunities for field practice very limited due to the heavy growth of timber and underbrush; topography too flat and lacking in variety.

Meanwhile the Chicago, Milwaukee & St. Paul Railroad had extended its line to Trout Lake, Wisconsin, and we were advised to look over that region before chosing a permanent camp site. This the writer did during the summer of 1913 and it seemed as though the upper lake offered the proper requirements for a camp site, together with facilities for field practice, besides being but a short distance from the headquarters of the Wisconsin State Board of Forestry. The country is open; topography diversified. The camp site high and well protected; water supply excellent, and location on the shore of Trout Lake, beautiful and only a short distance from the railroad.

The session of 1914 was therefore held at Trout Lake and the new camp site came up to our utmost expectations. Not only

was the camp site ideal, but our neighbors at the Forestry Headquarters, in charge of Mr. P. Christenson, proved exceptionally congenial and helpful. The Wisconsin State Board of Forestry leased to the Armour Institute of Technology about 7 acres of ground fronting upon the lake, with a frontage of about 1200 feet. At the same time an appropriation of $5,000.00 was made for the purpose of erecting buildings and for the purchase of a launch.

The buildings contemplated are: a two-story main building, 26'x52' with dining-room and assembly room on the ground floor and sleeping quarters for about 36 men on the second floor; a kitchen close to, but detached from the main building; a frame

The Kitchen During Construction.

building combining ice-house and woodshed; a boat-house, 14'x 40', capable of housing the launch and row-boats.

As soon as the regular session was ended work upon the buildings was begun in earnest. Meanwhile much of the excavating, leveling and clearing of ground had been done; stumps dynamited, piers built and sunk and dock built for boat landing. The building operations continued until September 5th, and during that time, from July 20th, the boat house was completed; the kitchen (of hollow tile) completed; and the woodshed and ice-house completed and in addition, the concrete foundation for the main building erected in place. It is intended to complete the main building during the coming summer.

The 35-foot Hunter launch equipped with Buffalo engine, arrived July 18th, and was launched about August 15th. This boat is especially adapted to our purposes, drawing only 20 inches

1. The Administration Tent. 2. A Typical Living Tent. 3. The Thirty-five Foot Launch on Flat Car at Trout Lake Siding. 4. The Noonday Rest. 5. Waiting for the Dinner Horn. 6 and 7. In the Field. 8 and 9. Parties on a Tramp.

of water and will enable us to reach almost any part of the lake in connection with our field work.

We feel now that the ultimate end of our endeavors is in sight. In establishing a permanent camp site and erecting permanent buildings we have had in mind not only the best inter-

ests of the Armour Institute of Technology, but the interests of the students as well. It must be distinctly borne in mind that attending the session of the Summer School in Surveying, the student suffers no hardships; every possible provision is made for his comfort. Indeed the session should be looked upon in the nature of an outing, and while there is much and serious work to be done, there is time too for much pleasure. Swimming, fishing and rowing, with occasional launch rides; base-ball and hand-ball (later, probably tennis) may be indulged in and at the end of the session, due to outdoor exercise, sleeping in the open and regular habits, the young man is physically fit. The expense too is not great; for Armour Institute men the entire expense including tuition, living and railroad fare need not exceed $80.00; for outsiders $95.00.

The field work from now on will be more effective; permanent bench-marks will be established; monuments erected and a definite programme outlined for each session. It is also proposed to offer instruction in certain subjects aside from surveying, provided enough applications are received; such instruction to be offered for the purpose of removing conditions, securing advanced standing; and may apply to either students of the Armour Institute of Technology or to students from or about to enter other engineering schools.

It is proposed therefore to make the work of the Summer School in the Wilderness, an integral part of the work of the Armour Institute of Technology. The same discipline; the same methods of instruction and the same degree of effectiveness are to be required.

In conclusion, the writer wishes to express his appreciation of the untiring efforts of Asst. Professor Mr. John C. Penn in behalf of the Summer School; also of the untiring energy and devotion of Mr. C. A. Knuepfer of the class of 1915, who during the past two years has devoted himself heart and soul to the welfare of the Camp.

Camp Armour, Summer of 1914

BY J. C. PENN*

Considerable work was involved in the moving of the camp from Tomahawk Lake, the location of the 1913 camp, to Trout Lake. Although only twenty-three miles by rail between the two points, the lack of switching arrangements between the Northwestern and the St. Paul Railroads caused a delay in the delivery of the cars of almost a week. In the meantime, however, there was plenty of work to do at the new camp site. When first located, the place for the future encampments did not look exceptionally promising. The rough and irregular land was covered largely with second growth timber and a rather heavy growth of underbrush. The slashings from the old lumbering operations were piled in enormous heaps all over the land, making clearing somewhat tedious. With the discovery of an old logging road leading from the main road into the camp, and with the possibilities of a beautiful site on this bluff overlooking the lake, once the land was cleared, the outlook brightened considerably. Further the land extending for miles back of the camp offered wonderful opportunities for a variety of field work.

Ten days were spent in preparing the place for occupancy. When the students arrived, the commissary tent, kitchen, supply tent, cook's tent and dining tent had been erected below the hill, while an instrument tent and some six living tents were set up above. The preliminary work included the driving of a well, the rebuilding of the ice box, the clearing and burning of all underbrush for a radius of several feet around each tent, and the cutting of paths from tent to tent. Adding to these items the fact that all goods had to be hauled by wagon from the cars on a siding a mile away, and the delay in shipment before mentioned, it can readily be seen that the "make-up" men had their difficulties in getting the camp in shape. The place is gradually beginning to look more like a park and the foresight of those who picked the spot is well rewarded.

The first day that the students arrived at camp was spent in

*Class of 1905. Assistant Professor of Civil Engineering, Armour Institute of Technology.

unpacking, getting acquainted with the surroundings, trying out the new boots, khaki trousers, etc., and getting the tents fitted with cots, tables, lamps, lanterns, hand axes, water pails and cans, cups and wash basins. The living tents are sixteen feet square by ten feet in height with four foot side walls, thus giving plenty of floor space and head room. A tent was usually assigned to a party of four, and, as far as possible, these four were also in the same surveying party. The usual few found themselves without baggage the first day and spent that night comfortably or otherwise, depending upon the generosity of their tentmates.

The schedule for the day, as posted and adhered to as closely as possible, was as follows:

5:45 A. M.	First horn, to get up.
6:00 A. M.	Second horn, last call.
6:15 A. M.	Breakfast.
7:00 A. M.	Parties with their instruments leave camp for the forenoon's work.
11:00 A. M.	Return to camp.
11:15 A. M.	Swimming.
12:00 M.	Dinner.
1:00 P. M.	Leave camp for afternoon's work.
4:30 P. M.	Return to camp, check instruments, and put field notes in shape, until—
5:15 P. M.	Swimming.
6:00 P. M.	Supper.

(Note: It was found after careful inquiry that a curfew was not needed.)

The schedule sounds rather formidable, but on closer investigation it will be noticed that only forty-four hours of the week (Saturday afternoons off) were devoted to surveying, the rest of the time being spent in whatever manner the student desired. The time consumed in the "mess" tent undoubtedly took up a large part of each day. It seems almost inconceivable the amount of "flapjacks," porridge, eggs, bacon, ham, etc., consumed each morning, to say nothing of an enormous dinner eaten after the morning's tramp and swim, and a big supper at the close of the day.

"Armour Bay" with its shelving beach and sand bottom and

its clear, cool water was all that could be desired for both bather and swimmer. The evenings in camp were usually spent in fixing up notes, writing letters, playing cards, telling camp fire stories, boating, and, probably most of all, playing baseball.

Plane Table Work Under Difficult Conditions.

The days were so long that it was not uncommon to see the boys from the State House and from Camp Armour in deadly combat after eight o'clock. The State Forestry students have their surveying in conjunction with the Armour students, but live at the Forestry Headquarters about one-half mile from camp. Plenty of material and rivalry were thus furnished for "scrub" games and even "match" games. The diamond could have been better, but in the heart of the woods it was to the boys as good as a perfectly finished diamond.

Saturday afternoons and Sundays hung heavily for but a few, for the majority needed all the time for "washing clothes," and for general repairs on same, boating, tramping around, fishing, and last, but not least, letter writing. The outgoing mail on Monday morning was always unusually heavy, increasing as the season advanced. The boating and fishing could not be excelled. The Armour boys were not always the lucky ones, but big fish were regularly caught in Trout Lake and the lakes in the vicinity. A fishing license is required for non-residents in Wisconsin.

The work of the encampment included the following:

(a) Practice in measuring lines with tape and pins, ranging in lines, staking out right angles with tape and pins, and pacing.

(b) Differential leveling.

(c) Adjustment of the level.

(d) Running a traverse with transit, measuring deflection angles, interior angles, singly and by repetition, azimuth angles, bearings and lengths of sides. The same traverse was also used in running a closed level circuit.

(e) One mile of railroad was staked out by each party and the work noted under parts (f) to (j) inclusive was carried out in connection with it.

(f) Profile leveling.

(g) Laying out circular curves.

(h) Platting a profile and establishing a grade line.

(i) Cross-sectioning.

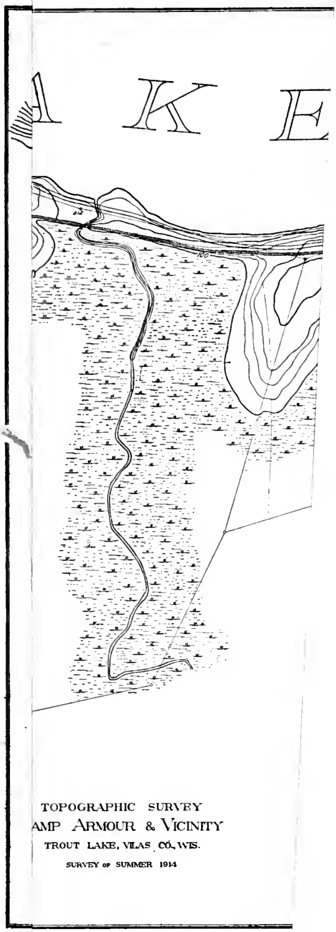
(j) Topography with hand level.

(k) One day was spent by each party on work with the solar attachment in the determination of meridian and latitude.

(l) Adjacent polygons were assigned to the various parties and a topographic survey with transit and stadia was made of each polygon.

(m) A part of each polygon was platted with plane table.

(n) Practice was given in measuring a base line, and measuring angles for triangulation, although nothing in the way of a permanent triangulation was attempted this year.


A K E
100
TOPOGRAPHIC SURVEY
AMP ARMOUR & VICINITY
TROUT LAKE, VILAS CO., WIS.
SURVEY OF SUMMER 1914

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(b) Differential leveling.

(c) Adjustment of the level.

(d) Running a traverse with transit, measuring deflection angles, interior angles, singly and by repetition, azimuth angles, bearings and lengths of sides. The same traverse was also used in running a closed level circuit.

(e) One mile of railroad was staked out by each party and the work noted under parts (f) to (j) inclusive was carried out in connection with it.

(f) Profile leveling.

(g) Laying out circular curves.

(h) Platting a profile and establishing a grade line.

(i) Cross-sectioning.

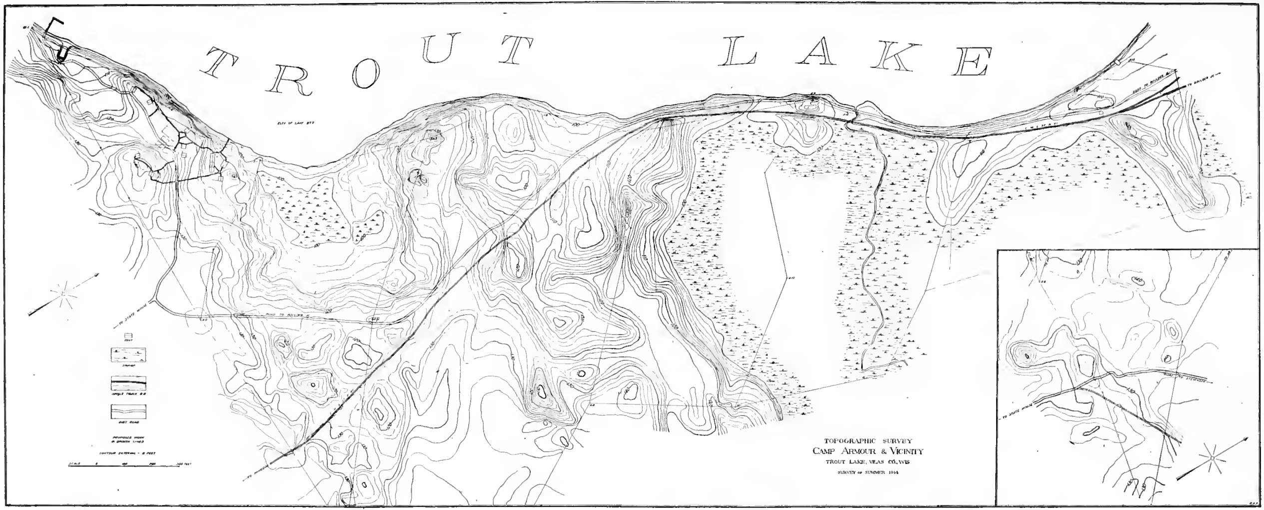
(j) Topography with hand level.

(k) One day was spent by each party on work with the solar attachment in the determination of meridian and latitude.

(l) Adjacent polygons were assigned to the various parties and a topographic survey with transit and stadia was made of each polygon.

(m) A part of each polygon was platted with plane table.

(n) Practice was given in measuring a base line, and measuring angles for triangulation, although nothing in the way of a permanent triangulation was attempted this year.



Scale 300 Ft. = 1 In.

(h) Practice was given in measuring
measuring angles for triangulation, although nothing in the way of a permanent triangulation was attempted this year.

The railroads staked out by the various parties did not necessarily follow the most economical location, but furnished a great variety of instrumental work and very often, on account of the poor location, gave the students plenty of individual problems to combat. The figuring of closing error, balancing of the survey, the computation of areas of the fields measured, of the closed traverse, and the calculation of lengths of the inaccessible distance in the triangulation furnished work for the rainy days.

The polygons mentioned under (1) were adjusted so that adjacent ones had several common points. In the first semester of the Sophomore year, each student platted one of these polygons to a certain scale. A tracing was then made of the series, each in its proper place, the result being the map which accompanies this article. The intention is to take up a new section along the shore of Trout Lake each summer, so that finally the north end of Trout Lake will be entirely surveyed. Points of accurate control will be obtained by triangulation.

This year, the camp did not "break up" at the end of the six weeks work. The students departed, but the "make-up" men and a few additionals stayed. Some of the tents were moved to allow for the dynamiting of stumps which were on or near the location of the proposed buildings. The instrument tent was converted into a stable, another tent into a cement shed, and the work of making the camp a permanent place started in earnest.

The launch arrived the day after the boys left and in a short time it was in its element. A landing pier, a boat house, an ice-house, a kitchen of terra cotta tile were practically completed, and the concrete foundations for the main building laid before the summer's end. Enough tile and lumber are on the job to finish the buildings. Most of the help left on September fourth, several remaining for another week to complete the packing and storing for the winter. A great deal of credit must be given the boys who worked with such interest on the buildings. The boys who stayed thruout the summer were: George Sproesser, Theodore Kiene, Bradley Carr, Guy Wetzel and Claude Knuepfer of the Class of 1915 and Henry Rook of the Class of 1916.

And so ended another never to be forgotten Summer Camp.

CENTRIFUGAL FIRE PUMPS

BY E. E. MAHER*

The inspection department of the Associated Factory Mutual Fire Insurance Companies issued June 1st, 1911 a specification on Centrifugal Fire Pumps, stating—"These specifications are now used through-out the whole country having been agreed upon in joint conference by representatives of the different organizations interested in this class of work. They will be known as "The National Standard" and have been . . . adopted by the following Associations:—

Associated Factory Mutual Fire Insurance Companies.

National Board of Fire Underwriters.

National Fire Protection Association."

At the same time the National Board of Fire Underwriters issued "Rules and Requirements for the construction and installation of Centrifugal Fire Pumps," this being a revision of their very short specification on "Electric Fire Pumps" issued in 1904. Aside from some general remarks concerning the investigation of conditions governing each installation the two specifications are identical. The Chicago Board of Underwriters, whose installations conform in general to National Standard specifications issued October 27th, 1911, supplementary specifications on Centrifugal Fire Pumps .

The National Standard Specification requires Centrifugal Pumps used for Fire Protection service to have certain characteristics:—

Rugged construction and ample strength in all parts.

Liberal water passages.

Working parts of non-corrodible material where exposed to corrosion.

Special fittings, such as discharge casting, hose valves, capacity plate, pressure and vacuum gauges.

Pumps must be of not less than two, nor more than four stages; maxium speed must not exceed 1800 R. P. M.; minimum efficiency of each size, with corresponding minimum horse power of motive power are noted. Impeller characteristic such that

*Ex-Class of 1905. Chicago Manager, Lea-Courtenay Company.

it will not be possible to overload the motor more than 25 per cent. Minimum width of water passage 5/8 inch. The standard sizes of centrifugal pumps are listed.

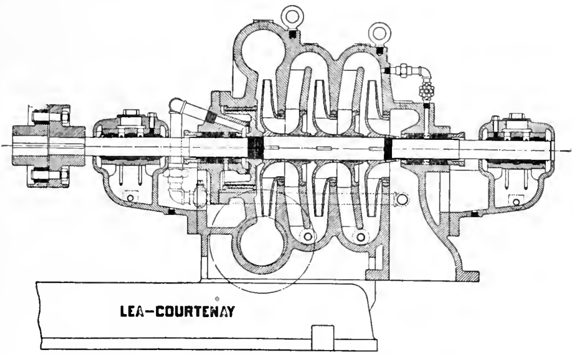


Fig. 1. Three Stage Single Suction Pump. Balanced Type.

Size of pump (Gal. per min.)	Suction Inlet	Discharge Outlet	Shaft Diam.	Eff. Per cent	H. P.	No. of Hose Valves	Size of Relief Valve
500	6	6	1¾	50 to 55	64 to 60	2	3″
750	8	8	2¼	55 to 60	88 to 80	3	3½″
1000	8	8	2½	60 to 65	107 to 100	4	4″
1500	10	10	3	65 to 70	148 to 138	6	5″

Quality of materials and workmanship are given attention. Manufacturers are required to submit complete working drawings; these when approved are the basis for construction of a pump which, after being built under the supervision of the Inspection Department is given a complete test, which if satisfactory entitles the manufacturer to apply for listing under approved apparatus . Acceptance is usually given after satisfactory test, provided designs of all sizes which are to be built are submitted together with agreement not to change any detail of material or workmanship without approval. Manufacturer is required to have certain facilities and in general is supposed to

be responsible for satisfactory field test of any fire pump he sells, no matter to whom, the idea being to require him as far as possible to make, or at least supervise his own installations. The Associated Factory Mutual Fire Insurance Companies list of "Approved Fire Protection Appliances" of April 1915, shows eight approved certrifugal Pumps.

The National Standard Specification ordinarily calls for man-

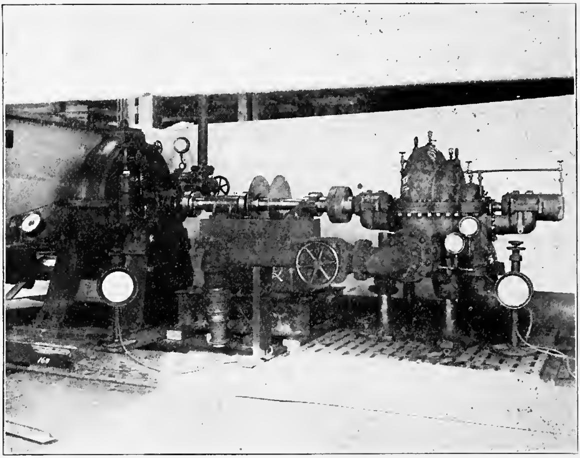


Fig. 2. Shop Test of Two Stage Fire Pump Set Above Tank, Showing Testing Turbine and Torsion Dynamometer with Necessary Gauges.

ual control for motor drive, open motor and splash partition between pump and motor. Manual controller to have voltmeter, ammeter, circuit breakers, main line switch and butt contact hand starter. Motor to have water proof windings where practicable, and to meet specifications of A. I. E. E. The only deviation from standard motor design is in the position of field and armature leads which are required to be brought through the top of motor frame, due to installation methods employed in the past by electricians when connecting up service from control panel to standard motors. Splash partition is usually wider than pump and extends where convenient to ceiling of room.

The specifications of the Chicago Board of Underwriters require (1) Motors to be fully enclosed fan ventilated. (2) Start-

Fig. 3. Direct Current Manual Controller Meeting the Requirements of the Associated Factory Mutual Fire Insurance Companies.

ers to be combined hand and automatic. Following from October 27th, 1911 "Specifications for motors and controllers."

MOTORS

Ventilation.

Motor must be ventilated by means of a suitable fan on motor shaft either inside or outside of motor casing, preferably draw-

ing, rather than blowing air through casing with inlet at top over commutator or slip ring, and discharge on in-board side above center line. Air inlet and outlet to have suitable flanges for bolting sheet metal pipe connections, or if desired inlet and outlet openings may be protected by suitable louvres cast integral with motor frame.

Efficiency and Test. LL

Motor must have net efficiency of at least 85½%; must be thoroughly tested in shop where built and copy of shop test must be submitted where acceptance tests are made after installation. Acceptance test shall consist of not less than two hours nor more than ten hours continuous operation; temperature rise in windings must not exceed 40° Centigrade, and bearings must run cool.

CONTROLLERS

Type

Controllers shall be of the combined automatic and manual type, preferably so designed that either manual or automatic operation may be obtained without the use of a throw-over switch or other transfer medium.

Operation

The automatic operation shall be initially actuated by a pressure governor acting directly on the winding of a solenoid or other device or devices which in turn shall close the main contact and a series of rheostatic switches admitting current to and cutting out starting resistance from the motor circuit. The period of motor acceleration shall ordinarily not exceed 10 seconds, and such acceleration period shall be governed by either a suction air dash-pot or other device. The manual operation shall preferaby be obtained from a crank or lever by which, without change of motion, the main contact and rheostatic switches shall be closed in proper order. All devices must return to starting position in case of failure of voltage. Means shall be provided for limiting the rapidity of acceleration when the controller is operated manually.

Starting Equipment

When two independent sources of current supply are provided there shall be mounted on the control panel a double or triple pole, double throw, knife switch, so connected that motor

may be operated from either service line; where only one service connection is installed a double or triple pole, single throw, knife switch must be provided. The panel shall also contain two single pole circuit breakers for direct current and a triple pole

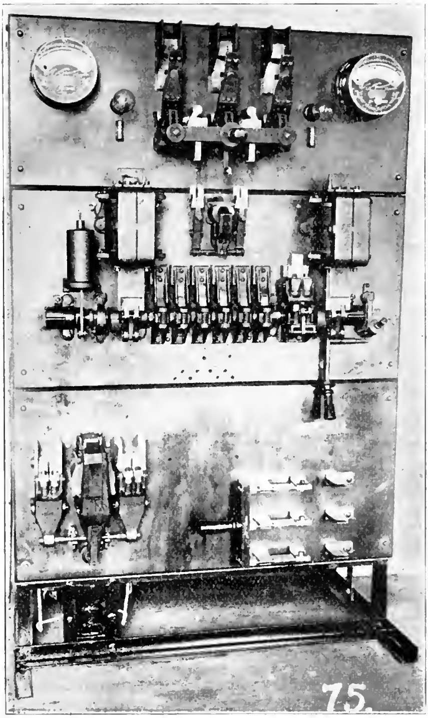


Fig. 4. Alternating Current Controller Meeting the Requirements of the Chicago Board of Underwriters.

circuit breaker for alternating current, calibrated to 300% above normal motor current; also two pilot lamps, one which will indicate presence of current on line, other lamp shall light only when the full operating cycle of panel is complete. Other apparatus shall also be mounted on panel-board as follows: Volt

meter, ammeter, resistance of the supported grid type and contacts, auxiliary field resistance which will increase motor speed 10% where direct current is used, approved automatic governor and recording watt meter. All wiring in back of board must be flame proof type except where busbars are used. Wires of opposite polarity must be rigidly supported.

NOTE:—Overload release devices will not be permitted. *No fuses* permitted except in voltmeter and pilot light circuits.

Panel

Panel shall be constructed of a high-class electrical slate supported by an angle iron frame, all to be enclosed in a ventilated splash-proof sheet iron or steel enclosing case with hinged doors both front and rear. The supporting frame shall be so arranged that bottom of slate will be not less than 24″ above floor.

INSTALLATION

Motor Connections

Feeders must be lead encased cable run in continuous metal conduit from street mains into approved metal cabinet in motor room; joints, if any, must be of wiped lead type. Leads from cabinet to motor to be lead encased in approved metal conduit enclosed in concrete if underground and dry; if damp vitrified tile ducts in concrete should be used. Size of conductors in B. & S. gauge shall be determined for direct current motors of respective sizes in H. P. and voltages on the basis of 90% efficiency and 25% overload. Size of conductors in B. & S. gauge shall be determined for alternating current motors of respective sizes in H. P. and voltages on the basis of 85% efficiency, 50% overload and 85% power factor. All conduit to be supported independent of woodwork. Motor terminals and conduit outlets must be properly waterproofed.

The Associated Factory Mutual Fire Insurance Companies generally accept installations with automatic and manual control in cases where National Board or Chicago Board Insurance Companies are insuring part of the risk with them, but almost always insist upon a manifold having passage carrying all water discharged by the pump. The Chicago Board standard manifold is a hood with bosses tapped for hose valves, set above pump discharge.

The intention of the Underwriters to make the pump manu-

facturer responsible for the completeness and proper operation of the entire installation has caused the manufacturers who are particularly interested in fire pump installation to fully meet the responsibility, with the result that there are now far fewer fire pump installations which cause difficulty at the start, or any other time, than formerly.

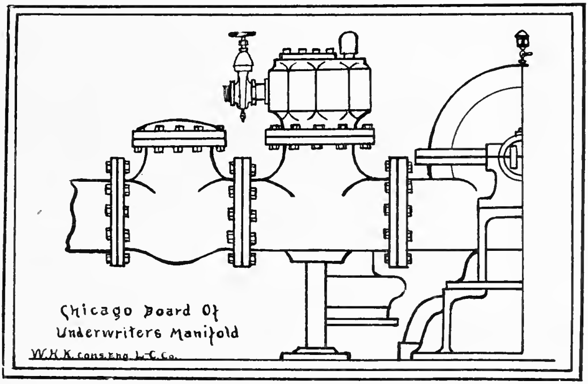


Fig. 5.

The pump manufacturer not only meets the present Underwriters requirements as far as quality of workmanship and materials are concerned, but far exceeds it. As illustrations, the minimum allowable efficiency for 1,000 Gallon fire pump is 60 per cent. It is to be noted that two tests shown in this article show pump efficiencies of 74.6 per cent and 77 per cent. Also that water quantity which can be delivered at the minimum required pressure usually exceeds the minimum by from 10 per cent to 35 per cent. Materials used are of the highest excellence, the Lea-Courtenay Company for instance using a Chrome nickel steel shaft of a larger diameter than required by the Underwriters to reduce the droop between bearings. The Underwriters take particular notice of this point as article 15 of their 1911 spcification reads as follows:

Shaft

The shaft must be of open-hearth carbon steel, oil-tempered or annealed, having a tensile strength of approximately 80,000 lbs.

per square inch. Maximum span allowed as follows:—

Size of Pump.	Span.
500 Gallons per minute	2 feet
750 Gallons per minute	3½ feet
1000 Gallons per minute	3½ feet
1500 Gallons per minute	4 feet

The additional expense for a nickel steel shaft is very much more than made up by the results obtained. Impellers, shaft sleeves, glands are of government bronze and wearing rings are of special non-corrodible bronze (referring to Lea-Courtenay pumps). Glands are split and removable. Packing is hand plaited Japanese hemp, properly sealed. Thrust bearing is water cooled.

The pump manufacturer finds it necessary to make more than a casual inspection of the type of motor which he proposes to

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Test No. 1.

The Chicago Board of Underwriters of Chicago, Incorporated 1861.

M J NAGHTEN, President
H G BUSWELL, Vice President G. S HASKELL, Treasurer.
H H GLIDDEN, Manager
R N TRIMINGHAM, Secretary E N GOODWILLIE, Supt's of
W D. MATTHEWS, Chief Surveyor. O. W. RAY, Ratings
ADDRESS ALL COMMUNICATIONS TO THE CORPORATION

Insurance Exchange
175 W. Jackson St.
Chicago,

March 29, 1915.

Albert Dickinson Plant, 35th and Washtenaw Ave.

FIRE PUMP TEST.

Motor. G. E. 150 H. P. 3 P. 60 cy. 220 V. 1800 R. P. M. Stator 338 A. Roto 228 A. Primary leads 1,000,000 C. M. Sec. leads 500,000 C. M. Service leads 700,000 C. M.

Panel Board. Sundh Electric Co. Circuit breaker, Sundh Electric Co. 400 A., 230 V., A. C., 500 A. tp 1,400 A set at 1,400 A. Swith, Trumbull Electric Co., 400 A. 250/500 V. A. C.

Ammeter Wagner, 0-800 A. Voltmeter Wagner 0-250 V. 8 resistance steps.

PUMP. Lea-Courtenay Co. Centrifugal fire pump. Capacity 1,000 gallons against 150 lb. pressure or 4 smooth 1⅛″ nozzle fire streams. D of impeller 16⅛″, 1820 R. P. M. Cushion tank 2,000 gals. with a relief valve.

Two High Tension Services. 3-250,000 C. M. 12,000 V. each. Oil switch C. B. on each service 500 A. Condit and Wsetinghouse. Two banks of 3-200 K. V. A. Trans. 12,000 V. to 220 V. 60 cyc.

Pittsburg and G. E. types. High side of transformers protected with 35 A. fuses. Either set of transformers can be connected to main switchboard thru disconnecting switch. Total switchboard load 3,000 H. P.

No.	Time	R. P. M.	Volts	Amperes	Average Volts	Average Amperes	Av. Elec. H. P. Input	Av. Elec. H. P. Output	Suction Pressure	Discharge Pressure	Av. Net Pressure	1⅛″ Nozzle Pressure
1.	10:55	1797	225	210					30	227		
2.	11:00	1780	225	210					30	227		
3.	11:05	1780	225	210					30	230		
4.	11:10	1766	225	200					30	227		
					225	207	91.8	78			198	
5.	11:20	1770	225	300					28	215		155
6.	11:30	1780	225	300					28	215		155
7.	11:35	1780	225	300					28	215		153
8.	11:40	1790	225	300					28	215		153
					225	300	133	113			187	
9.	11:45	1780	220	370					27	200		140
10.	11:50	1780	225	370					26	198		141
11.	11:55	1787	225	370					26	198		141
12.	12:00	1783	225	370					26	200		141
					223	370	162.6	133.1			173	
13.	12:05	1780	220	420					24	178		126
14.	12:10	1778	220	420					24	178		126
15.	12:15	1777	220	420					24	176		126
16.	12:20	1778	220	420					24	176		126
					220	420	182	155			152	
17.	12:25	1780	220	440					20	156		109
18.	12:30	1775	225	440					20	155		109
19.	12:35	1770	220	440					20	155		108
20.	12:50	1769	220	430					20	155		108
					221	434	189	160.3			135	
21.	12:50	1796	225	200					30	227		
					225	200	88.7	75.3			197	

No.	1⅛″ Nozzle Press.	1⅛″ Nozzle Press.	1⅛″ Nozzle Press.	Average Nozzle Pressure	Average Gallons Per Min.	Efficiency	Remarks
1.							Shut off
2.							Shut off
3.							Shut off
4.							Shut off
5.							1 Stream
6.							1 Stream
7.							1 Stream
8.							1 Stream
				154	470	45.3	
9.	134						2 Streams
10.	134						2 Streams
11.	134						2 Streams
12.	134						2 Streams
				138	900	65.7	
13.	120	125					3 Streams
14.	120	125					3 Streams
15.	120	125					3 Streams
16.	120	125					3 Streams
				124	1260	72.6	
17.	103	108	105				4 Streams
18.	103	108	105				4 Streams
19.	102	107	104				4 Streams
20.	102	107	104				4 Streams
				106	1520	74.4	
21.							Shut off

Remarks: No glass bull's eyes in doors of cabinet.
Note: Automatic test, acceleration, 9 secs.; rest, 20 secs.; running, 2 secs.

use as trouble has been found with a number, due to their not meeting heating requirements as well as for other operating reasons. As a general proposition the fully enclosed fan ventilated motor is but little larger than the open motor of the same capacity and speed ,but commutator on Direct Current motor has to be of special construction, due to the uniform high speed of fire pump apparatus, and to the fact that fan ventilation does not seem to reduce heating in iron core of commutator to the same extent that it does fields and armature.

The controller is by all odds the part most likely to cause trouble in a fire pump installation. The first difficulty found is in getting the Underwriters Associations to agree to construction of any particular panel as a standard due to constant changes in construction, and controllers which are satisfactory one year, are discarded the next. The second point is the fact that the Underwriters make such a minute inspection of acceptable apparatus that little over-sights in construction or installation are severely penalized—sometimes to the extent of holding up acceptance of the apparatus until changes are made Further, the starter manufacturer in his laudable ambition to make better apparatus at a lower price than anyone else will sometimes change details of apparatus without the "formality" of obtaining consent from the Underwriters most interested. This cannot help but have a prejudicial effect on the entire installation.

Satisfactory equipment secured, installation should be done with care. Fire pump installations usually include the delivery and setting of pump, motor and controller on foundations furnished by fire pump manufacturer, the electric wiring from a source of supply either in the street or within a few feet of controller, and sometimes the Underwriters' standard compressor or compression tank, if required. In not a few cases, the suction pipe from source of supply including water meter is also specified. It is thoroughly advisable to have the installation laid out and made completely by someone who has had experience with a number of jobs. Final test made as it is under the supervision of the Underwriters, and requiring the presence of not less than three engineers, not to speak of the firemen and fire apparatus required, should be preceeded by a test made by the

manufacturer. When work is completed, a careful examination of wiring, installation and bearings of pump and motor should be made and pump started off delivering a water quantity equivalent to not less than one-third of its rated capacity. (In the case of 1000 Gallon pump delivery through a 2½″ hose line with open butt, or two 2½″ hose lines with 1⅛″ nozzles, would be satisfactory). Fire pump under preliminary test should not

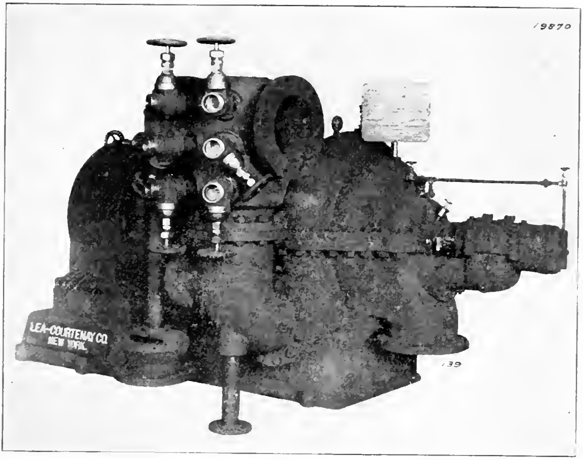

Fig. 6. 1500 Gallon Fire Pump for 100 lb. Working Pressure, Similar to Duplicate Outfit Installed at Recreation Pier. (Municipal Pier, No. 2, Foot of Grand Avenue, Chicago.) National Standard Manifold.

be started without water, or without discharging water, and care taken that thrust bearing is supplied with water, and that it runs cool. If everything is satisfactory at the end of a short test it is safe to turn installation over to Underwriters for their test.

Tests of the Chicago Board of Underwriters usually cover a period of two hours with readings at five minute intervals. They usually start pump completely shut off, then open one, two, three, four nozzles, and in some cases, where there seems to be danger of greatly overloading the apparatus, continue the test until the maximum quantity of water obtainable through the pump is ascertained. You will note from the Albert Dickinson

Test No. 2.

The Chicago Board of Underwriters of Chicago, Incorporated 1861.

M J NAGHTEN, President
H G BUSWELL, Vice President G S HASKELL, Treasurer
H H GLIDDEN, Manager
R N TRIMINGHAM, Secretary. E N GOODWILLIE } Supts of
W D MATTHEWS, Chief Surveyor O W RAY } Ratings
ADDRESS ALL COMMUNICATIONS TO THE CORPORATION

Insurance Exchange
175 W. Jackson St.
Chicago,

January 28, 1915.

DE WOLF FIRE PUMP TEST, ABERDEEN & ADAMS STREETS, CHICAGO

Motor. G. E. 100 H. P. 360 A. 230 V. 1600 R. P. M. Enclosed.

Pump. Lea-Courtenay. 1000 gallons. 1600 R. P. M. 100 lbs. Impeller 14″. 4-1-⅛″ smooth nozzle hose streams.

Panel. Sundh Co. Main switch 400 A. 250 V. D. C. & 500 V. A. C. I. T. E. 600-1600. Set at 1080.

Governor. G. E. Type.

Feeders. 700,000 C. M. cables.

Double-throw, four-pole switch is used to permit the use of the elevator circuit to fill the tanks.

No.	Time	Volts	Amp.	R.P.M.	Streams	H.P. Output	Remarks	1″ Nozzles	Discharge per min. in Gallons
1.	1:02	236	100	1438			Shut off		
2.	1:10	234	140	1500	1	43.4			
3.	1:15	232	140	1480	1	39.2			
4.	1:30	234	145	1500	1	41			
5.	1:25	234	145	1507	1	41			
6.	1:30	230	145	1510	1	41			
7.	1:45	230	225		3	62.5			
8.	1:48	232	220	1517	3	60.4			
9.	1:50	230	245	1550	4	69.2			
10.	2:00	230	240	1550	4	66.6			
11.	2:25	235	265	1575	4	74.9		69-71-71-71	975
12.	2:45	230	280			77.7	Automatic		

No.	Suction Pressure	Discharge Pressure	Net Pressure	Per Cent Efficiency
1.	28	137		
2.	26	135		
3.	27	135		
4.	27	137		
5.	27	137		
6.	27	137		
7.	22	122		
8.	22	122		
9.	19	108		
10.	19	108		
11.	16	112	96	77

Defects—Compound conduit outlets at motor and panel.
Rigidly support busses on rear of panel.
Support air line at girder.
Increase speed of motor 25 R. P. M.
Repair defective ammeter.
Replace hose on regulator with solid pipe.
Provide drain connection for water-cooled bearing.

Attention is called to the fact that no shunt meter has been provided for the fire pump service line.

Fire Pump test that a determination of the maximum quantity of water was not secured. This was due to the fact that the head had dropped 17#, and water quantity increased 260 Gallons over reading nearest full load, with increase in Horse Power of only 5.3, a net of 160.3 Horse Power, being well within the overload capacity of the motor, which would be expected to have a capacity of not less than 187.5 Horse Power continuously for two hours. As a matter of fact, the motor ran very cool. (Under remarks covering this test "No glass bull's eyes in doors of cabinet," bull's eyes were removed to avoid danger of breakage when pump was being tested).

The test of the DeWolf fire pump was purposely confined to two hours, as it was evident that the pump would deliver its full rated quantity without over-loading the motor. The speed did not come up to that rated, due to the fact that starting under less than half load (beween 1 o'clock and 1:45 load was less than 42 H. P. and between 1:45 and 2:25 less than 70 H. P.) the motor ran practically cold which cut down the net discharge pressure. The last fifteen minutes of this run was made on the automatic controller, the drain valve in tank being open, and the motor

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CLEVELAND INSPECTION BUREAU, CLEVELAND, OHIO

Capacity Test of Fire Pump

On July 12th, 1914, a capacity test was made of the Lea-Courtenay fire pump installed in the new May Company building, Euclid Avenue, this city, which is in connection with the automatic sprinkler equipment. Piezometer readings were taken at the nozzles, and the output of the pump in gallons figured accordingly.

The electrical readings were taken from the volt and ammeter on starting panel.

A series of readings were taken under different conditions during a continuous run of one hour and fifteen minutes with the result indicated in the accompanying table:—

No. of Streams.	Gal. per minute	Pump pressure	Volts	Amperes	Speed	Pres. at nozzle
One wide open	438	200	228	500	1389	136
One throttled	260	200	228	420	1316	48
Two open	876	185	226	640	1358	130
						142
Three open	1266	175	225	700	1358	125
						130
						124
Four open	1647	155	228	780	1383	120
						118
						121
						120
Four throttled	1028	200	228	740	1473	47
						47
						47
						47

It will be noted that the pump has a greater capacity than that for which it is rated. The pump ran smoothly and when shut down at the end of the above mentioned time, the bearings were in excellent condition.

Owing to the electrical instruments not being properly calibrated the electrical readings are somewhat questionable.

—L. W. Theis.

starting and cutting out as rapidly as the pressure was built up. The efficiency of pump shown is considered remarkable, in view of Underwriters restrictions on water passages. Under defects:

First:—"Compound conduit outlets at motor and panel"—oversight by electricians.

Second:—"Rigidly support busses on rear of panel"—complaint due to fact that several insulated wires were likely to come in contact with busbars.

Third:—"Support air line at girder."

Fourth:—"Increase speed of motor 25 R. P. M."

(These two items do not require explanation). —

Fifth:—"Repair defective ammeter"—re-calibration of volt meter or ammeter on direct current service is often necessary.

Sixth:—"Replace hose on regulator with solid pipe"—this order was due to the fact that supplier had endeavored to anticipate the wishes of the Underwriters instead of conferring with them as to what he proposed to furnish. This hose was wire wound, equipped with porcelain connectors, which it was thought would be more satisfactory for connection to air line than a solid brass pipe.

Seventh:—"Provide drain connection for water-cooled bearing"—the drain connection was on at the time of installation, but was not properly connected into suction of pump.

Eighth—"Attention is called to the fact that no shunt meter has been provided for the fire pump service line."—this refers to a recent ruling by the City of Chicago Electrical Inspection Department that shunt wattmeter in iron box located as near as possible to service entrance is to be furnished for every fire pump intsallation.

Regarding the test on the May Company Building, attention is called to the Bureau's statement regarding the greater capacity shown thon for which pump was rated. Also note it was necessary to recalibrate the instruments.

The specifications of the Chicago Bureau of Fire Prevention and Public Safety cover automatic equipment only, and special care has been exercised to keep the cost of installations down to as low a figure as consistent with efficiency. Specifications of September 26th, 1913, include a 250 Gallon pump in addition to the sizes required by other Boards. Efficiency of 250 gal-

lon size not less than 40%. Pump to be capable of withstanding a pressure of 200% of its working pressure, maximum speed not over 1800 R. P. M. Note—pumps of the 250 and 500 gallon size may be single stage, when pressure at pump does not exceed 75 pounds.

Motor may be of the open type with splash proof partition between pump and motor. The controller differs particularly from the Chicago Board Controller in that wattmeter and ammeter are not required and many equipments operated by float switch are installed and accepted. The Chicago Board recognizes only diaphragm pressure regulator controllers.

Capacity of electric apparatus is based on the following formula given by the Chicago Bureau of Fire Prevention.

$$H.P. = W \times \frac{65}{E} \times \frac{P}{100} \times \frac{85}{E'}$$

E = Efficiency of pump.
E′ = Efficiency of motor.
P = Working pressure at pump in lbs. (head plus friction).
W = 25 for 250 gallon pump.
50 for 500 gallon pump.
75 for 750 gallon pump.
100 for 1000 gallon pump.
150 for 1500 gallon pump.

The Bureau of Fire Prevention and Public Safety make tests in a manner similar to those conducted by the Chicago Board of Underwriters. In general, a test is sufficient that demonstrates a capacity equivalent to that required, and at the required pressure, provided the equipment is complete and properly installed. The City ordinance under which the Bureau of Fire Prevention operates requires the installation of fire pumps in many buildings already constructed. Many old buildings present difficulties for the Bureau of Fire Prevention, and a consideration of the requirements of the Ordinance, together with the necessity for not working any uncalled for hardship on owners or tenents, has in the past required special consideration in each instance. It may be said that in no case where a fire pump has been installed subsequent to September 23rd, 1913, has there been acceptance of any but the type of apparatus shown in specifi-

cation. The following is a resume of a recent test made with a two stage 250 gallon per minute Lea-Courtenay fire pump with a 230 volt 1750 R. P. M. Lincoln motor and Sundh controller:—

Test No. 3.

Time	Volts	Amperes	R. P. M.	H. P. Input	H. P. Output	Streams	Pump Pressure	Nozzle Pressure	G. P. M.	Suc. Pressure	Efficiency
No. Load	235	45	1620	...	...	.....	125	..	...	29	....
1:15	230	98	1637	30.1	27.	1-1¼	99	64	362	28.	49%
1:20	230	98	1634	30.1	27.	1-1¼	99	64	362	28.	49%
1:25	230	100	1650	30.8	27.	1-1¼	101	65	365	28.5	57%
1:30	230	100	1650	30.8	27.	1-1¼	101	65	365	28.5	57%
1:35	230	100	1653	30.8	27.	1-1¼	102	65	365	28.5	57%
1:40	232	100	1660	31.	28.	1-1¼	102	65	365	28.5	57%
1:45	234	100	1667	31.	28.	1-1¼	103	65	365	28.5	
1:50	237	102	1673	32.	29.	1-1¼	103	66	368	28.5	
1:55	237	102	1688	32.	29.	1-1¼	104	66	368	28.5	
2:00	237	102	1704	32.	29.	1-1¼	104	66	368	28.5	
2:05	237	102	1696	32.	29.	1-1¼	105	67	370	28.5	
2:10	237	102	1700	32.	29.	1-1¼	105	67	370	28.5	

It will be noted that Horse Powers are based on a 90% motor efficiency which is probably giving the motive power the best of it. This test was in every respect satisfactory to the Bureau of Fire Prevention.

1½″ stream on automatic control, 3½ cycles, 4 accelerations, three rests per minute. Ranges—87½ lbs. to 102 lbs. pump pressure. Twelve seconds rest.

150′ 2½″ cotton rubber lined hose equipped with 1¼″ shut off nozzle used on this test.

Following is a test which failed, due to the fact that water was delivered through a 3″ suction line, 220 ft. in length with not less than three bends.

Single stage 500 gallon per minute pump.

Motor, 35 H. P. 87.5 Amp. 220 volt. 1800 R. P. M. 3 phase, 60 cycle. Rotor 84 Amp. 220 volts.

Test. No. 4.

Time	Volts	Amperes	R. P. M.	Pressure	Streams	H. P. Input	H. P. Output	Vac. Suc.	Nozzle Pressure
No. Load	205	60	1780	110 lb.	1	21.	18.9	8	53
11:30	205	77	1760	86 lb.	1	20.	18.	8	53
11:35	205	76	1790	86 lb.	1	20.	18.	6	53
11:40	205	75	1756	86 lb.	2	23.	20.7	?	20-20
11:45	205	85	1756	35 lb.	1	20.	18.	4	53
11:50	205	75	1756	86 lb.	1	20.	18.	4	53
11:55	205	76	1756	86 lb.	1	20.	18.	6	53
12:00	205	76	1796	86 lb.	..	...	...	..	..

Note:—Water supply inadequate when two hose streams were attached.

It will be recalled that all Boards of Underwriters have minimum power ratings for motive power. The National Board standard based on minimum efficiencies of 50% for the 500

Gallon pump, 55% for the 750 Gallon pump, etc., and a pressure of 100 lbs. net require as a minimum 60 H. P. and 80 H. P.,

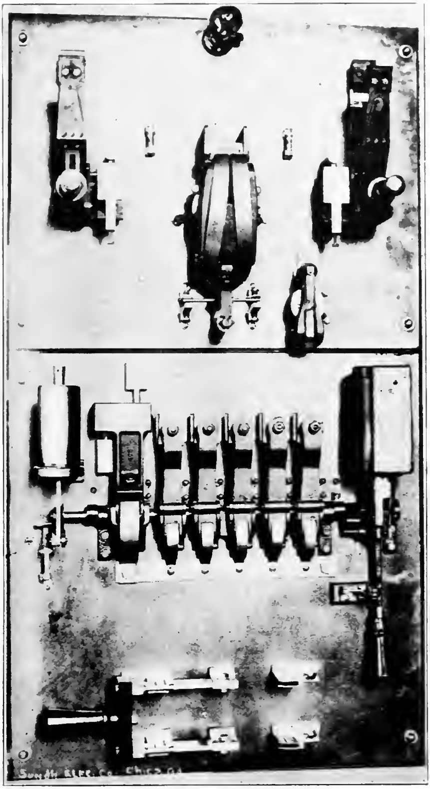

Fig. 7. Direct Current Automatic Control Panel, Meeting the Requirements of the Chicago Bureau of Fire Prevention and Public Safety (Enclosing Case Not Shown).

etc. The Chicago Bureau of Fire Prevention standard is about equivalent as shown in their formula. The evident intention of the Underwriters is to require a Horse Power based on the guaranteed pump efficiency, but not in any case less than the minimum rated Horse Power. If 100 Horse Power is required for

a certain pump at 100 lbs. pressure, 150 Horse Power should be required for the same pump at 150 lbs. pressure. There is a tendency, due to close competition for contractors to use Horse Powers less than the required minimum in case any condition arises which would make possible a successful evasion of the requirements. As an example, a 500 Gallon pump delivering against 150 lb. pressure with an efficiency of 55% requires 78 H. P. The contractor who installed this pump actually used a 75 H. P. motor. This, in spite of the fact that the Underwriters show a maximum allowable efficiency and a minimum Horse Power rating of 55% and 60 Horse Power for 100 lbs. pressure. This job had a feeder several hundred feet in length which due to the small motor was very much smaller than should have been installed. There is no question that a correct interpretation of Underwriters rules would have required a motor of more than 80 H. P. Consulting Engineers should insist upon liberal feeders, starters of adequate size, and above all on motors that are fully capable of carrying the maximum load, which pump can put on them, indefinitely, or at least for a period of eight or ten hours. If adequate motive power is provided, together with satisfactorily installed feeder from source of electrical supply, the electric fire pump becomes very satisfactory and reliable.

As a further illustration of the pains which the Underwriters Associations take for adequate motive power, the steam turbine driven pump is of interest. A Turbine driven pump can only be installed under conditions as expressly stipulated by the Underwriters, but as a usual thing the Turbine must be of such capacity that exhausting against the maximum back pressure which may be put upon the line, it will handle the maximum Horse Power which can be put on it with an initial steam pressure not over one half that usually carried in the plant. This reserve allowance insisted upon is especially notable as a Turbine driven fire pump is usually not accepted for a steam plant unless there are usually several boilers in operation.

Attention has already been called to the simplicity of the specification of the Chicago Bureau of Fire Prevention and Public Safety, their requirements covering apparatus which will start with certainty when called upon, but eliminate a number

of the features which are insisted upon by the Chicago Board of Underwriters, and the National Board of Fire Underwriters. The present installations made under the requirements of the Chicago Bureau of Fire Prevention are of a satisfactory character and many of the Chicago Board of Underwriters installations are also required to meet the requirements of the Chicago

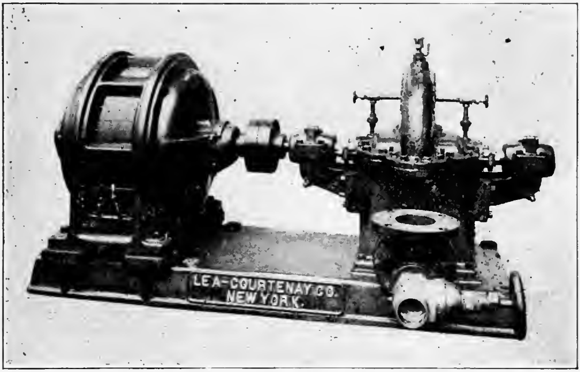

Fig. 8. 250 Gallon Fire Pump for 65 lb. Working Pressure, Meeting Requirements of the Chicago Bureau of Fire Prevention.

Bureau of Fire Prevention. Among recent illustrations may be mentioned the Recreation Pier (Municipal Pier No. 2 City of Chicago) where two Lea-Courtenay 1500 Gallon fire pumps for 100 lb. pressure with Allis-Chalmers direct current fully enclosed fan ventilated motors and Sundh combined hand and automatic starters are installed to meet the Chicago Bureau of Fire Prevention requirements as well as those of the Chicago Board. Also the new Buck & Rayner—State & Adams Building, where a Lea-Courtenay 500 Gallon three stage fire pump for 175 lb. pressure meets the requirements of the Bureau of Fire Prevention as well as the Chicago Board. The latter illustration is of some interest on account of the fact that at a speed of 1600 R. P. M. an efficiency of 55% at 175 lbs. pressure with a three stage pump is guaranteed.

The installations of the Chicago Board of Underwriters are usually very complete, and a high grade of apparatus is almost

invariably installed. Their specifications are made to eliminate undesirable apparatus, and a field test will usually determine any point on which the equipment is not up to standard. The fully enclosed fan ventilated motor as made to meet the Chicago Board of Underwriters specifications usually runs very cool and with excellent commutation under considerable overloads, and with greatly varying heads. Controllers must be especially well constructed, and a number of refinements adding considerable to their present height of efficiency have been recommended.

The Associated Factory Mutual Fire Insurance Companies use generally a hand controller allowing only a rugged and well constructed piece of apparatus. Their specification permits the use of motors which are not always the best suited for fire pump service, but low quality motors are automatically eliminated. The present aim of the Associated Factory Mutual Fire Insurance Companies seems to be to determine what goes into each job on the merit of each job. With this in view it will be found that many Engineers consulting the Associated Factory Mutual Fire Insurance Companies' Engineers before getting bids are enabled to determine exactly what is wanted, and sometimes can save their clients money.

The City of Chicago, and many other bodies whose work brings them in connection with fire prevention installations and requirements have taken great interest in installations locally, and it can fairly be said that the City of Chicago has more up to date and highly efficient fire pump installations than any other city in the country.

ENGINEERING IN FARM LIGHTING.

BY P. G. DOWNTON*

One of the first things a graduate of an engineering school learns after leaving school is that engineering principles are not confined to large undertakings but can be applied to all things and that the failure of many things is due to the lack of such application.

The electric plant for Farm Lighting is a comparatively small thing but the number in use is so large that it is a subject of great importance from a commercial point of view. The difference between a good plant and a poor one is usually the result of the correct application of engineering principles in the manufacture and assembly of the parts constituting the plant in the one case and the incorrect one in the other.

It is the purpose of this article to show how the Farm Electric Plant has been developed and improved in this way. To do this, a short history of the Farm Plant proposition is necessary. The development of the Electric Lighting Plant for city and small town work is known to all. After electric lights had been proved a success for towns, some wealthy farmers and persons owning country homes began to consider electric lights for their homes. The result was that some plants were put in ten or fifteen years ago. It was only to be expected that these plants were just as close copies of the Town Plants as were commercially possible. These plants were successful but not economical. At that time the carbon filament lamp was used and the size of the plant necessary made the price prohibitive in most cases.

These plants were all 110 volt outfits and required all of the attention and care that Central Stations require and usually a regular attendant was lacking. The storage battery consisted of 56 cells or more and the attention a battery needs is usually proportional to the number of cells.

The introduction of the Tungsten lamp into commercial service was the principal factor in making the Farm Lighting Plant a success. Its use reduced the size of the plant required by about 60% so that the cost came within reason. With the prospect of the Farm Plant becoming a popular thing, the engineers of one of the large companies, interested in the proposition made a study

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of the conditions under which a Farm Plant must operate, to determine just how it should differ from the Town Plant to give the best service. It was found that a decrease in voltage was very desirable. This change meant decreased attention and improved service. The voltage was set at 32 which is sufficient for the ordinary distances of transmission encountered in Farm work. The Tungsten lamp had been found to give longer life in the lower voltage on account of the increased size of the filament for equivalent candlepower. The decrease in the number of cells meant an increase in the ampere hour capacity for the same watt hour capacity and in that way made use of commercial sizes of batteries rather than laboratory sizes. The decrease in the number of cells meant a decrease in the amount of labor required for their care and operation and also removed the danger there was connected with the operation of 110 volt plants.

The type of plant outlined above consisting of 32 volt generator, a 16 cell storage battery, a gasoline engine, and a switchboard was the one with which the Farm Plant business was built up. The type of battery that had been used with the 110 volt plants and was used with these 32 volt plants was known as the *"Chloride Accumulator"* assembled in glass jars. The plates were what is known as a composite type and, for this work, had all of the good qualities of a true Plante plate with the added advantage of being able to stand this class of service with far less injury than the Plante plate.

This combination made an ideal plant so long as conditions remained the same. These plants were installed by electricians familiar with storage battery installation. Soon, however, electricians not familiar with storage batteries wanted to sell and install plants. They did not want to have to learn storage battery installation work and did not want to spend the time required for the initial charge.

This created another demand for the engineer to meet. The *"Hyray-Exide"* battery. This battery is assembled in rubber jars and is charged ready for installation before leaving the factory. The Plates used in it are of the *"Exide"* or *"Faure"* type and while it is not anticipated that the life will be as great as that from the *"Chloride Accumulator"* type, a careful analysis of the conditions of operation leads to the opinion that a very satisfactory life will be obtained.

While the *"Hyray-Exide"* battery met all of the demands that were presented, the engineer who designed it felt that if a battery needing no expert installation were required, we should go even farther and produce a plant which would need no expert installation. This was done and the result was the *"Hyray-Exide"* unit plant. Figure 1 shows the plant ready to operate. The plant was all assembled on a skid with the battery at one end and the switchboard at the other. The generator was mounted between the two. The switchboard had a hinged joint

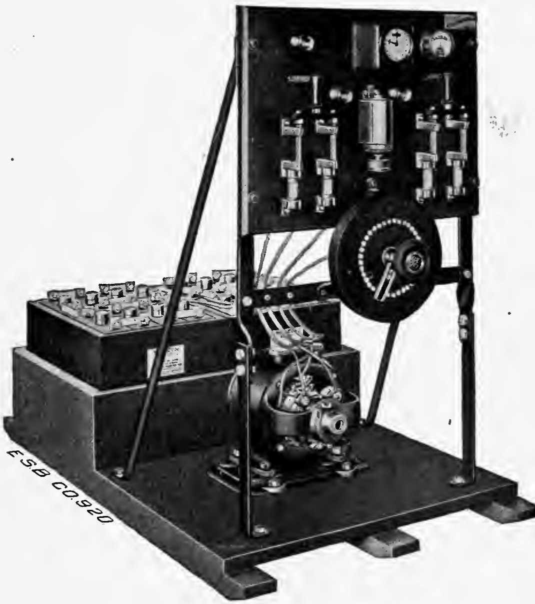

Fig. 1. Hyray-Exide Unite Plant Ready to Operate.

in its support so that it folded down for packing as shown in figure 2. A packing case could then be put over this whole thing, so that the plant reached its destination with all connections made and ready for operation. In this way there was no chance for connections being made wrong.

While this assembly accomplished the object sought ,the switch-

board was designed so as to give much more efficient service from the plant as a whole. The feature which permitted the radical change in operation was the use of a Sangamo Ampere Hour Meter. The obvious use of this instrument was to show the state of charge of the storage battery. Instead of necessitat-

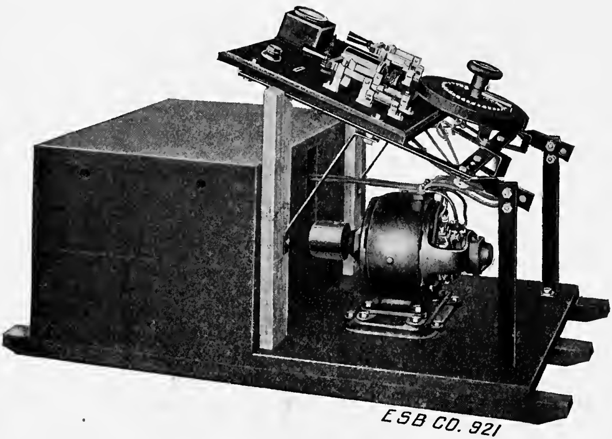

Fig. 2. Switchboard Folded, Ready for Packing.

ing the continual use of a hydrometer as in the past, the hydrometer could be used as a check in much the same way as a man checks his watch by a chronometer. The meter was compensated so that ordinary losses were taken care of.

The above use would have been sufficient to justify the use of the ampere hour meter but it had another important use. In the past it had been necessary to give instructions to charge storage batteries at what is known as the "normal" rate requiring approximately nine hours, but it is a well known fact, however that storage batteries can be charged at a higher rate when considerably discharged, the rate being dependent on the amount taken out of the battery.

The maximum efficiency is obtained when a battery is charged from a constant potential equal to about 2.35 volts per cell. It is almost impossible to follow this method in small plants, however. An interesting fact in this connection is that if a battery

is charged by the constant potential method and an ampere hour meter connected in the circuit, the current at any time will be almost exactly equal to the ampere hours discharged as shown by the ampere hour meter. This gives a good rule to follow.

In the past, a generator had usually been supplied having a

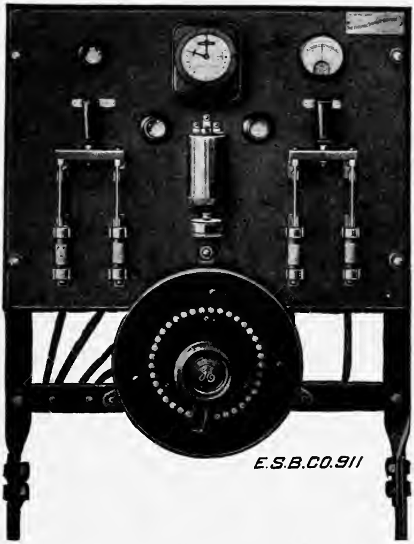

Fig. 3. Details of Switchboard.

capacity sufficient to take care of the connected load. This capacity in most cases was several times the "normal" charging rate of the battery with the result that the engine and generator were operated for about nine hours each charge at 50% load or less. This meant low efficiency. With the scheme outlined above the charge could be started at the full capacity of the generator and continued at that rate until the ampere hour meter reading equaled it. The current could then be decreased in as many steps as practical so as to keep it always less than the ampere hour meter reading. The larger the generator, the less time would be required for charging but with the sizes in general use the time was less than 6 hours or a saving in fuel of between

30% and 40%. It was also a saving in wear and tear and in the trouble incident to the long running of the engine.

In addition to the features already discussed, the operation was simplified to such an extent that the only part of the electrical equipment the operator needed to touch was the field rheostat controlling the generator voltage. When the engine is started, the voltage of the generator is raised until it is sufficient to begin charging the battery. At that time the automatic switch connects the generator to the battery and the voltage is adjusted to give the desired charging rate. When the engine is stopped, the switch opens. Figure 3 shows the details of this switchboard. The plant as outlined represents the best engineering practice in these small plants today but the same engineers who brought the plant up to its present standard are still working towards improvement and while the present result seems to be entirely satisfactory, there is no reason to believe that progress will not be made in the future as it has in the past.

CALCULATION OF DATA ON COALS AND CINDERS FOR HEAT BALANCE

BY P. W. EVANS *

It is the practice of most concerns operating steam boilers to run, from time to time, certain tests variously referred to as "coal tests," "evaporative tests," "boiler tests," etc. The information obtained from these tests is sometimes expressed in just one item, and that is, the pounds of water evaporated from and at 212° F. per pound of coal. Usually a sample of the coal is taken and its heating value determined. In such cases one other item of information is obtained from the test, and that is, the overall efficiency. But it is generally recognized that if a boiler test is to be of any definite use in assisting to locate and cut down losses, it must include the data necessary for the preparation of a detailed heat balance. When this heat balance has been carefully worked out, the various losses are then made evident, and it only remains to apply such remedies as may be thought expedient to reduce each of the individual losses to the point which is in accordance with good practice.

The principal information which must be obtained to make a reliable heat balance possible are accurate data on flue gas analysis taken both from the point where combustion has been completed and from the uptake of the boiler, the ultimate analysis and the heating value of an average sample of the coal as fired to the furnace; and the heating value of the cinders. This, of course, presumes that all of the great many precautions necessary to secure accurate results, particularly as regards weights of coal, water, and cinders, and the correct determination of the average quality of the steam, have been observed while conducting the boiler test.

But though an ultimate analysis is of consderable importance, the expense of making it is often prohibitive and, besides, it requires several days or, in some cases, weeks before it is possible to get the sample to a chemical laboratory and have the analysis made. When a series of tests is being run with the idea of improving efficiency, it is a matter of great importance to

*Class of 1912. With Armour and Company, Motive Power Department, Sioux City, Iowa.

know immediately after the close of the test or, at most, on the next day, just what results have been obtained, so that on the succeeding test an attempt may be intelligently made to cut down those losses which were shown by the heat balance to be abnormal. For this reason it is also particularly desirable to know the heating value of the ash with as little delay as possible. For the engineer in the field to make calorimetric determinations and coal analyses would mean that he would have to carry around with him a very well equipped chemical laboratory, something which is ordinarily impracticable. A method by which the ultimate analysis and consequently the heating value of coal, as well as the heating value of cinders, may be closely approximated by the engineer on the job, is given in the following:

Bulletins Nos. 22 and 85, issued by the Bureau of Mines, contain a large number of ultimate analyses of coals from all parts of the country. When these analyses are expressed on a "free from moisture, ash, and sulphur" basis, a very interesting point is brought out: coals from any given locality show practically the same analyses when expressed in this manner. It has been found convenient in working up heat balances to express the oxygen combined with the proper amount of hydrogen as "combined moisture" and to refer to the remaining hydrogen as "free hydrogen." To illustrate the point above mentioned, all of the ultimate analyses given in the government bulletins Nos. 22 and 85, for the states of Illinois, Indiana, Iowa, and Kansas, were expressed on the basis referred to. These analyses are given in the appended tabulatons, from which the marked uniformity of the coals from the same general locality when expressed on this basis, is evident. An average of these analyses from the states of Illinois, Indiana, and Iowa, is as follows:

State.	Number of Samples.	Combined Moisture.	Free Hydrogen.	Carbon.	Nitrogen.
Illinois	63	11.94	4.14	82.40	1.52
Indiana	25	11.02	4.47	82.96	1.55
Iowa	5	11.27	4.55	82.68	1.50

The coals from the Cherokee District of Kansas show a decided difference, the average of eight samples giving the following:

Combined moisture	6.38
Free hydrogen	5.04

Carbon	87.13
Nitrogen	1.45

An average of four samples from Leavenworth and Linn counties, Kansas, gives the following:

Combined moisture	9.37
Free hydrogen	4.62
Carbon	84.46
Nitrogen	1.55

Considering this uniformity in the anaylses of coals from the same localities, a knowledge of the district in which the coal was mined determines with sufficient accuracy its analysis on this basis. It is then principally a question of determining the amount of free moisture and ash in the coal. This can be very simply done without any elaborate chemical apparatus. In addition, the amount of sulphur in the coal must be assumed. As the sulphur content does not run very uniform, some little error may be introduced in making this assumption. However, for the principal purpose that the ultimate analysis is desired the matter of sulphur content is only of very little importance, since the heating value represented by the sulphur is not very great and the air required for the combustion of the sulphur is only a small portion of the total requirement. An example of this method of calculating the ultimate analysis and corresponding heating value of a particular coal, will make the point clear. Assume a coal from Illinois which shows total free moisture as fired 4.1% and ash 13.7%. The average sulphur content of samples from Illinois, Indiana, Iowa, and Kansas, as reported in the Bureau of Mines' bulletins, is as follows:

State.	Samples.	Average per cent Sulphur in Sample as received.
Illinois	133	2.84
Indiana	70	3.11
Iowa	18	4.72
Kansas, Cherokee District	26	4.75

Assuming the per cent sulphur in the sample of Illinois coal under consideration to be as above, the total moisture, ash, and

sulphur would be 20.6% of the coal as fired. The ultimate analysis of the coal as fired may then be calculated as follows:

Combined moisture (11.94 × .794)	=	9.5
Free moisture	=	4.1
Total moisture	=	13.6
Free hydrogen (4.14 × .794)	=	3.3
Carbon (82.40 × .794)	=	65.4
Nitrogen (1.52 × .794)	=	1.2
Ash	=	13.7
Sulphur	=	2.8
		100.0%

The heating value of this coal from the usual formula gives 11680 B. T. U. per pound as fired. In this particular case a heating value determination was made with an oxygen bomb calorimeter, which showed 11500 B. T. U. per pound as fired. This same calculation has been made for a great many other samples of coal, and it has been found that the heating value as calculated in this manner checks up with sufficient closeness the heating value as determined by the bomb calorimeter. The variation is seldom greater than is shown in this particular instance. It is best to work out in detail the ultimate analysis as outlined above for each sample, but, if desired, the heating value can be calculated with only a small error for the coals referred to above, by assuming 142 B. T. U's. per 1% total coal less free moisture and ash for Illinois, Indiana and Iowa coals and 151 B. T. U's. for coals from the Cherokee District of Kansas.

As mentioned previously, this method of calculating ultimate analyses affords not only a means for closely approximating the heating value of the coal, but also data necessary to calculate the air supply per pound of coal from a knowledge of the flue gas analysis, which is, of course, of the greatest importance in working up a heat balance.

Further data necessary to calculate the heat balance includes a knowledge of the heating value of the ash. With most cinders this may be determined with fair accuracy by means of an oxygen bomb calorimeter, but there is usually more or less doubt about this determination; besides it is open to the objection that it must usually be made in a chemical laboratory. During the

past year a number of these determinations have been made in the laboratory of the company with which the writer is connected. The amount of ash in the cinders, together with volatile combustible and fixed carbon, as well as the heating value, was reported for all samples. It was found that there was a decided uniformity in the ration between the heating value and the total per cent combustible. The B. T. U.s per 1% combustible in the cinders was worked out for all of the samples run, which resulted in the following:

Coal from	Number of Samples.	Average B. T. U. Per 1% Combustible.
Illinois	72	141
Indiana	2	157
Kans., Cherokee Dist.	20	142
Penn., Scranton Dist.	16	143

From this it is considered that sufficient accuracy will be obtained by simply making a determination of the amount of combustible in the ash, an dthen calculating the heating value from the average B. T. U.s per 1% combustible determined from previous tests, as those just given. This determination of combustible in the ash may be readily made by the engineer on the job, without any very elaborate chemical apparatus.

ULTIMATE ANALYSES OF COAL, FREE OF ASH, SULPHUR. AND FREE MOISTURE. TAKEN FROM BUREAU OF MINES' BULLETINS NOS. 22 & 85.

County	Location of Mine	No. of Samples	Combined Moisture	Free Hydrogen	Carbon	Nitrogen
		Illinois Coal				
Clinton	Germantown	1	12.66	4.48	81.37	1.49
Clinton	New Baden	1	11.88	4.32	82.37	1.43
Franklin	Benton	1	11.42	4.08	82.64	1.86
Franklin	Sesser	2	12.96	3.85	81.52	1.67
Franklin	West Frankfort	1	11.84	3.17	82.24	1.75
Franklin	Zeigler	7	11.88	3.70	82.71	1.71
La Salle	La Salle	1	12.05	4.63	81.98	1.34
Logan	Lincoln	1	11.60	4.27	82.59	1.54
Macopin	Staunton	4	12.50	4.28	81.87	1.35
Madison	Collinsville	4	12.28	4.42	81.93	1.37
Madison	Donkville	2	12.66	4.35	81.65	1.34
Madison	Livingston	3	12.99	4.25	81.47	1.29
Madison	Maryville	2	12.20	4.22	82.21	1.37

County	Location of Mine	No. of Samples	Combined Moisture	Free Hydrogen	Carbon	Nitrogen
		Illinois Coal				
Madison	Troy	2	13.40	3.89	81.18	1.53
Marion	Centralia	1	12.54	4.28	81.75	1.43
Montgomery	Coffeen	2	13.43	4.14	80.89	1.54
Montgomery	Paisley	1	12.07	4.45	82.02	1.46
Montgomery	Panama	1	11.81	3.90	82.95	1.34
St. Clair	O'Fallon	2	12.45	4.52	81.74	1.29
St. Clair	Shiloh	1	13.50	4.38	80.79	1.33
St. Clair	Worden	1	12.33	4.32	81.88	1.47
Sailne	Harrisburg	4	10.98	4.22	83.14	1.66
Sangamon	Auburn	1	12.94	4.25	81.43	1.38
Sangamon	Springfield	1	11.66	4.41	82.40	1.53
Vermilion	Westville	1	12.60	4.06	81.60	1.74
Williamson	Bush	4	11.43	4.12	83.05	1.40
Williamson	Carterville	7	10.46	4.19	83.74	1.61
Williamson	Herrin	3	11.16	3.90	83.29	1.66
Williamson	Marion	1	10.73	4.10	83.40	1.77
	Average		11.94	4.14	82.40	1.52
		Indiana Coal				
Clay	Brazil	1	11.01	4.42	82.99	1.58
Greene	Linton	2	11.68	4.25	82.43	1.64
Knox	Bicknell	1	12.15	4.11	82.53	1.21
Parke	Rosedale	1	11.08	4.84	82.58	1.50
Pike	Ayrshire	2	11.34	4.22	82.88	1.56
Pike	Hartwell	1	11.27	4.47	82.68	1.58
Pike	Littles	2	10.25	4.72	83.51	1.52
Sullivan	Dugger	3	11.04	4.28	82.88	1.80
Sullivan	Hymera	2	9.92	4.69	83.86	1.53
Sullivan	Mildred	1	10.96	4.42	83.00	1.62
Sullivan	Star City	1	11.80	4.18	82.42	1.60
Vigo	Macksville	2	11.37	4.56	82.64	1.43
Vigo	Seelyville	1	11.99	4.63	82.10	1.28
Vigo	Terret Haute	2	10.40	4.65	83.67	1.28
Warrick	Boonville	2	11.07	4.59	82.70	1.64
Warrick	Elberfeld	1	10.35	4.63	83.31	1.71
	Average		11.02	447	82.96	1.55
		Iowa Coal				
Appanoose	Centerville	1	11.61	4.38	82.74	1.27
Lucas	Chariton	1	12.77	4.44	81.13	1.66
Marion	Hamilton	1	11.27	4.40	82.04	1.99
Polk	Altoona	1	11.03	4.81	82.89	1.27
Wapello	Laddsdale	1	9.69	4.42	84.56	1.33
	Average		11.27	4.55	28.68	1.50
		Kansas Coal				
"Cherokee District"						
Cherokee	Scammon	1	6.35	5.12	87.02	1.51
Cherokee	West Mineral	1	7.76	4.83	86.11	1.30
Crawford	Fleming	1	7.10	4.91	86.60	1.39
Crawford	Frontenac	1	4.93	5.25	88.29	1.53
Crawford	Fuller	1	5.73	4.95	87.79	1.53
Crawford	Yale	1	7.23	5.10	86.39	1.28
Crawford	Yale	1	5.94	5.05	87.46	1.55
Crawford	Yale	1	6.00	5.10	87.42	1.48

County	Location of Mine	No. of Samples	Combined Moisture	Free Hydrogen	Carbon	Nitrogen
		Kansas Coal				
	Average		6.38	5.04	87.13	1.45
Leavenworth	Lansing	1	9.81	4.55	84.08	1.56
Leavenworth	Leavenworth	1	9.53	4.63	84.28	1.56
Leavenworth	Leavenworth	1	9.54	4.63	84.23	1.60
Linn	Jewitt	1	8.58	4.66	85.28	1.48
	Average		9.37	4.62	84.46	1.55

THE MORKRUM TELEGRAPH PRINTER†

BY H. L. KRUM*

As the Morkrum telegraph printers are being quite extensively used, and through their performance attracting general attention, a description of the system will be of interest.

The inventions involved in this system are the joint work of Mr. Charles L. Krum, a mechanical engineer, and Mr. Howard L. Krum, an electrical engineer, and the development of the system is due to Mr. Joy Morton, a capitalist of Chicago, the name Morkrum being a contraction of Morton-Krum.

As its name indicates, the apparatus is designed to operate a typewriter over a telegraph line. An operator working on a keyboard, similar to that of a standard typewriter, sends out over the line signals, which actuate a typewriter at the distant end of the line. All the functions of the typewriter which are normally controlled by hand, such as turning up a new line, or bringing the carriage back to start a new line, are controlled from the keyboard at the sending end of the line, and all this is done over a single wire, which is also operated duplex; that is, the transmission of messages in both directions over the wire can be accomplished simultaneously.

Very early in the development of the system it was determined that upon the simplicity of the line currents used would depend the ability of the printer to operate successfully under the varying conditions of weather and line interference, and that to meet these requirements it was essential that the signaling current should be of single strength and with no zero position. Accordingly, it was made identical with the Morse polar duplex, securing all the reliability of that system, with its ability to work duplex successfully over long lines, and also making it possible to repeat through direct point repeaters.

Two methods of transmitting are used in the Morkrum system; first, the direct-acting keyboard system in which the operation of the keyboard at the sending end actuates the printing mechanisms at the receiving end directly, without any intermediate operations; and, second, tape transmission, in which the messages are first prepared on a perforated tape by means of

*Class of 1911. Electrical Engineer, The Morkrum Company, Chicago, Illinois.

a keyboard perforator. This tape is then used to automatically transmit the signals over the line at a high rate of speed. The printing mechanism at the receiving end is identical in either case, whether the transmission is accomplished by means of direct keyboard operation or by the use of the perforated tape and automatic transmission.

The selective system is based on a five-unit alphabet. That part of the line signal which controls the printing of letters, or the operation of the other functions of the typewriter, is divided into five time intervals, and the selective signaling is accomplished by combinations of reversals of polarity of the current sent to the line during these five time intervals. This allows thirty-two selections to be made over the line, and by using a shift of the typewheel, fifty-three letters, figures and characters can be printed.

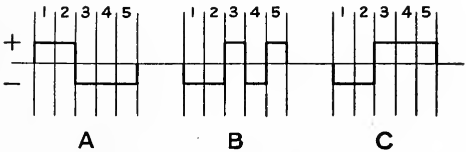

Fig. 1. Line Signal.

Fig. 1 illustrates this method of signaling. In the letter "A," positive current is sent to the line for the first two time intervals, and negative current for the last three time intervals. These signaling currents operate the polar relay at the receiving end, and the currents of negative polarity are used to control the selective mechanism.

As in this system there is never to exceed three, and an average of only two, signal currents sent to the line for each letter, the frequency of the line signal is very low. This is important, as the higher the frequency of the signals and, consequently, the shorter the duration of the signaling currents, the greater becomes the difficulty of actuating the selective mechanism in a positive manner. The low frequency, which is considerably below that of Wheatstone and other automatic apparatus at equal capacity, has given great reliability, particularly in bad weather; and there have been numerous instances where the Morkrum has been able to work through severe storms that have

made the working of wires extremely difficult. This feature, combined with the reliable synchronizing system, has made the Morkrum valuable for long line printer work heretofore considered impracticable. There are a number of long circuits in duplex operation, with from two to five repeaters.

Fig. 2 shows a printer unit mounted on a keyboard for direct transmission. When a letter on the keyboard is depressed it sets up five polechangers in the combination which corresponds to that key. The transmission of the signal thus set up is accomp-

Fig. 2. Keyboard and Home Recorder.

lished by a brush revolving on a commutator. When the key is depressed a clutch is released which allows the brush to make one revolution and transmit the signal to the line.

The keyboard action is very light, requiring only a slight touch to start it, the stroke being completed by an electromagnet, and it can be operated all day with much less fatigue than an ordinary

typewriter. It also has a key lock which holds the key down until the complete signal has been sent and also prevents any other key from being depressed until the signal for the preceding letter has been completed.

In the keyboard system the selection at the receiving end is accomplished by means of a bank of relays, which successively connect five lock relays, which control the printing mechanism, to the contact point of the main line relay. Before sending out the selective signal the motor transmitter sends out a starting pulse, which starts the action of the receiver bank.

The direct keyboard system is not synchronous in the ordinary sense of the word, but is roughly isochronous; that is, the re-

Fig. 3: Morkrum Perforator.

ceiving mechanism is adjusted to run at approximately the same speed as the transmitting mechanism, and a governing rheostat is provided to regulate the speed of the receiving mechanism. With this arrangement, any difference in the transmitting and receiving speed is not cumulative, as the receiving mechanism and the transmitting mechanism start together at the beginning of each letter. The receiving mechanism is arranged so that it connects the selective locks to the line relay for only a short portion of the duration of each time interval of the transmitted signal; in other words, only the peak of the wave is used by the receiving mechanism, and this fact allows of considerable distor-

tion of the wave form without affecting the action of the selecting mechanism.

For tape transmission, a tape a little wider than a Wheatstone tape is used, and the various combinations are formed by a series of holes punched crosswise on the tape instead of lengthwise, as in the Wheatstone tape. This reduces the length of tape required for a message to about one-sixth of that of a Wheatstone tape, an ordinary message requiring but eighteen inches of tape.

Fig. 3 shows the Morkrum keyboard perforator, which has a keyboard similar to that of a standard typewriter. There are six rows of holes on the tape. The continuous row of small holes is used to feed the tape in the transmitter. Different combinations of holes in the five remaining rows, which are placed two in front of and three behind the feed row, represent the different signals to be transmitted and control the polarity of the five selective impulses which are sent over the line for every signal.

In the tape system, as in the keyboard system, the selective mechanism is controlled by different combinations of polarity of five time intervals.

The five pole-changers used in transmission, instead if being controlled directly by the keyboard, are controlled by the arrangement of holes in the perforated tape. At the transmitting end a brush revolving on a commutator transmits the signals set up by the tape to the line, but instead of being controlled by a clutch, as in the keyboard system, this brush revolves continuously. At the receiving end there is a similar commutator to which the five selective locks are connected, and there is also a continuously revolving brush.

It is apparent that the brushes of the transmitter and the receiver must be over corresponding segments at the same instant. To accomplish this means are provided for keeping them in unison. The brush at the receiving end is run at a speed which is slightly faster than that of the brush at the transmitting end. The transmitter brush sends out a correcting pulse every revolution and this operates a correcting mechanism at the receiving end which will retard the receiver brush sufficiently to keep the two ends in unison.

The typewriter used in connection with the system was specially designed for the purpose. A revolving typewheel is used,

and the five selective impulses control a mechanical selecting device which regulates the rotation of the typewheel and stops it opposite the proper letter.

The platen of the typewriter is stationary, and the printing mechanism moves, which is the reverse of typewriter practice. The printer accomodates all standard telegraph blanks, and the stationary platen is of considerable advantage in feeding blanks, also when it is desired to use a large roll of paper in the printer.

With the direct keyboard system it is customary to use a home recording printer with a roll of paper. In tape transmission the tape is the home record and no home printer is required.

With this system it is not necessary for the operator to understand the Morse code, as anyone who can operate a typewriter

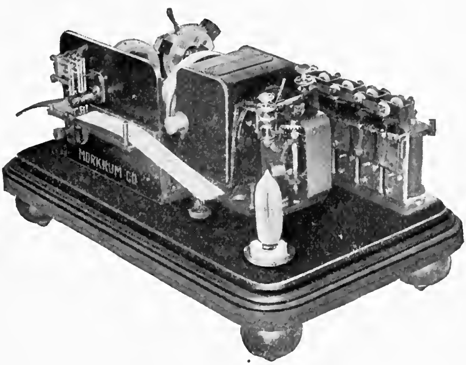

Fig. 1. Morkrum Distributor.

keyboard can do the work. This system also greatly increases the capacity of the telegraph lines.

The direct keyboard and tape transmission systems each have their special uses, depending upon the length of the line and on the character and volume of business to be handled.

The direct keyboard system operated duplex has a capacity of about eleven hundred commercial messages in a nine-hour day. The tape operated system has a capacity of about two thousand commercial messages in a nine-hour day.

The Morkrum printers were first introduced in regular service by the Postal Telegraph-Cable Company between New York

and Boston. That circuit has been in regular operation for several years, and a number of other circuits have been installed by that company.

The Western Union Telegraph Company is using the Morkrum tape system quite extensively on its main lines all over the country, the longest circuits being those in operation between Chicago and San Francisco, and Chicago and Los Angeles, about twenty-three hundred miles, with four repeaters each. A circuit from New York to San Francisco, a distance of thirty-six hundred miles, with six repeaters has also been successfully operated duplex.

The Morkrum printing telegraph system is extensively used in Canada by both the Canadian Pacific Railway and the Great North Western Telegraph Company, the latter having several circuits working with Western Union offices in the United States. A number of principal railroads in the United States are using the Morkrum system, among which the Chicago, Burlington and Quincy, the Rock Island Lines, New York Central, Lake Shore, and Baltimore and Ohio. The Morkrum system has also been installed by the Associated Press for the delivery of news to the newspaper offices.

QUOTATION FROM THE "SERVICE BULLETIN" OF THE ASSOCIATED PRESS, NEW YORK, APRIL 5TH, 1915

"Morkrum Telegraph Printing Machines Adopted

"With the installation of Morkrum Telegraph Printing Machines a radical change has been made in the method of delivering THE ASSOCIATED PRESS news report to the New York City papers. Heretofore the report has been delivered to some of the city papers over Morse telegraph wires; to others delivery was made by messenger. Today eight evening and nine morning papers are reeciving the entire report over two Morkrum circuits.

"The Morkrum system was adopted after exhaustive tests had demonstrated its practicability for the service required. These tests began last September when two circuits were installed between the office of THE ASSOCIATED PRESS at 51 Chambers Street and one of the afternoon papers. From time to time additional papers were equipped with the apparatus and connected with the circuits. In January all the afternoon papers

were receiving the day report over the Morkrum circuits, the delivery by messengers was abandoned and the city Morse wire discontinued.

"The day circuits proving a success, installation of the night circuits was completed in short order.

"The sending operator at THE ASSOCIATED PRESS office writes the press matter which is to be sent, on a keyboard similar to that of a standard typewriter. This keyboard prepares a perforated tape or paper ribbon which runs through a transmitter. The transmitter sends out combinations of electrical impulses over the wire to the various newspaper offices, actuating telegraph relays at these points, which in turn operate the printing units or typewriters, reproducing the writing of the keyboar doperator at THE ASSOCIATED PRESS office, or sending station. Thus the sending operator controls absolutely the typewriter at the distant end of the line and is able to transmit copy at the rate of about 60 words per minute, which is considerably faster than the work of a good Morse operator. With this capacity of approximately 7,000 words an hour for the two circuits the report is transmitted with practically no delay.

"At the receiving station the report is received on a roll of paper eight inches wide. An attendant delivers the copy item by item to the telegraph editor. The station is equipped, in addition to other apparatus, with a keyboard by which the attendant can communicate with the sending station in order to ask any necessary questions concerning the report.

ffl"If a receiving station wishes to talk with the sending station, the attendant presses a button which lights a lamp and also operates an audible signal at the latter point. That particular line is then switched on to the proper instrument and a conversation can be carried on with this one station without interfering with the operation to the others.

"In addition to the transmitting apparatus at the sending station there is a printer which records the matter transmitted exactly as it appears on the printers at the newspaper offices, and an error in transmission can be quickly noted and corrected."

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(Signed) AL. N. GROSSMAN,
Business Manager.

Sworn to and subscribed before me this 4th day of May, 1915.
[Notary Seal] JULIA BEVERIDGE,
Notary Public.

My commission expires January 8th, 1918.

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The Staff presents this, the last issue of THE ARMOUR ENGINEER under their management, to its readers with the hope that each reader may find something of interest and value to him. This issue is published according to a set of "Standards" worked out by the editors after a study of the preceding issues. The object of these "Standards" is to secure absolute uniformity of all matter in the book, thus presenting a better appearance.

The Staff considers itself fortunate in securing such highly valuable editorials as appear in this and previous issues. The Editors have been requested to induce these men, if possible, to write a series of editorials on particular subjects such as they have given us. This shows evidence of the value of the editorials to our readers.

The Editors wish to thank all who have so generously contributed to the support of The Armour Engineer during the past year. They are particularly grateful for the co-operation given them by Dean H. C. Raymond, Dean L. C. Monin, and Mr. F. G. Huechling and Mr. F. T. Bangs of the Armour Alumni Association.

THE ENGINEER AS A BUSINESS MAN

As Chairman of Subdivision 63—Engineers, Chicago Association of Commerce, the writer necessarily takes a keen interest in the business aspect of the engineer's profession.

It has been stated that for a period of time, covering several hundred years, the world was ruled by the warrior, then came the rule of the statesman, and now is foretold, the rule of the engineer, for efficiency and conservation are necessary and the engineer is the one to apply them, and these responsibilities placed upon his shoulders, necessitate his being a thorough business man.

For too long a time, has the engineer, with ill-judged modesty, assumed that he was only concerned with the theoretical and scientific part of his business and the proper designing and careful construction of the work entrusted to his care. Accepting his own valuation of himself, the rest of the world and especially the "business man" has considered him as a dreamer and planner, but not as an executive, and even now our great commercial bodies in organizing their committees which deal with and report upon engineering subjects, are reluctant to put upon these committees, their engineer members, for they say they wish "a business man" for this work, and so deprive us of our opportunity to serve with credit to ourselves and benefit to the organization, and deprive themselves of our advice and assistance. Everyone of us must realize that beyond the technical problems of our profession, there are the business problems, which concern us most vitally.

In the past there has been a feeling that the engineer's estimates of investment and operating costs could not be depended upon, and still less respect was paid the engineer's estimates of probable revenue. Today the engineer knows that estimating the returns of an engineering work, is more important than estimat-

ing the expenditures necessary for the construction of the same.

He must go thoroughly into the question of production, market and revenue, and if he cannot prove satisfactorily to himself, his clients and their financial backers, that the investment will be profitable, it is his duty to advise against the contemplated construction. So permit me for the future success of your readers, to suggest that they have this strongly in mind—the successful engineer, the man who is going to take the lead in his profession and be a ruler among men, is the engineer who not only has the ability to design and construct works of the highest mechanical efficiency and structural duration, but he who also can direct the work and effort of others, and can design the financial success of the enterprise so that failure is improbable. This engineer will have as his reward that financial and professional success which he merits, and will aid us all in winning a high place in the business world.

—*Edmund T. Perkins.*

THE POST GRADUATE COURSE FOR ENGINEERS

An engineer must specialize along certain specific lines if he hopes to attain success; he must not only give the best that is in him to his immediate calling, but he must also study and observe the relation of his work to that of the other lines which have a bearing thereon. For instance: the expert in the construction and maintenance of railroad track should not only master the subject of track construction, but he must also watch the developments that are taking place in the motors and the rolling stock which pass over the road. The man who designs an engine must absolutely know the uses to which that engine is to be put. We have a notable example of this in connection with the development of the steam engine. After it was generally believed that this machine had attained its maximum efficiency it was found that it was not suitable for generating electricity, and as a result the steam turbine was evolved.

It is very evident, therefore, that an engineer in order to be successful cannot be a recluse. He must associate with his fellow engineers. Now he can best secure such association through the technical societies. The meeting of engineers under con-

ditions where all are on a common footing fosters a spirit of kindly co-operation and helpfulness which binds them together and makes each of greater usefulness to the other. It is only by extensive co-operation that the best advancement can be made in engineering science and achievement.

As to the legal profession the decisions of the judges are entered and published, thus forming a basis of precedent for future use, so also it is desirable that records of important engineering work should be published in order that we may benefit by the experience of others. Many of the larger engineering undertakings are the result of the co-operation of several engineers who are proficient in their respective fields. It is, of course, customary to have a chief engineer at the head of any important enterprise, nevertheless, the work which he supervises is usually the product not of himself alone but of those also who are associated with him. It frequently happens that on large undertakings experts in various lines of the work are employed and the duty of the chief then consists in determining the general scope of the work, the special features being developed by these experts in their respective lines. For instance, the building of a large steel plant requires expert metallurgical engineers, electrical engineers, mechanical engineers and structural engineers. It is manifest then that as the work becomes of great magnitude it is most important that accurate records of the same should be made available. These records can best be promulgated through the procedings of Technical Societies.

Such published proceedings find their way around the world and furnish material to the Universities whereby recruits may be trained to successfully solve the problems of the day.

The literature published by the Technical Societies keeps the student abreast of the times; familiarizing him with the large problems with which engineers have to cope; and putting him in touch with the opinions and investigations of professional engineers who have devoted their lives to the development and progress of some special branch of engineering. The articles carefully read will be of great value to the student in solving his own problems in after life.

Technical Societies also afford the younger engineers the opportunity of obtaining the benefit of the experience of older en-

gineers, resulting from the fact that they are permitted to participate on an even footing in the discussion of the papers presented.

The older engineers should and generally do take great interest in the work of the student engineers, and the latter may greatly profit thereby.

The influence of the Technical Society and its value to the professional engineer is probably even greater than to the student. The practicing engineer is no longer under the guidance of professors and instructors and his opinions and development of ideas must be largely molded by those with whom he associates.

To be well educated involves not merely the mastery of knowledge, statistics and current events, but must also embody the broadmindedness which will admit the justice and good sense of the other fellow's opinions and beliefs. A comprehensive judgment of various views and solutions is only possible through the assimilation of ideas and associations such as an engineering society offers.

In the Technical Societies the various steps of mechanical development are depicted both from the practical and theoretical standpoint. They afford the engineer an opportunity to supplement his own knowledge by the experience of his fellow engineers. They afford him the opportunity to present to the world what he himself has accomplished and to receive criticisms and suggestions from his fellow men and, resulting from the discussion of the various subjects which are presented, the engineer learns to appreciate the benefits of co-operation; by means of which both the giver and receiver are greatly benefited.

—*Albert Reichmann.*

LOCAL TRANSPORTATION FOR CHICAGO

This is an interesting and important subject to every citizen of Chicago, but it has been threshed and buffeted about so much in politics for the past few years that the much needed traction improvements have been held back.

The only real step forward that has been made by the City authorities in the past four years has been the passage of the Unification Ordinance which amalgamated all of the surface

street railway lines into one operating company under one operating head, thereby fulfilling one of the principles laid down in the 1907 ordinances for the betterment of service. This should now be followed up as rapidly as possible by:

1. A reasonable rush hour service standard—the best that can be agreed upon to suit present conditions.
2. The unified operation of the surface and elevated lines under one operating head, with universal transfers between all lines.
3. The buildings of subways for the use of surface and elevated cars through the central congested district, to be extended as rapidly as possible, either as subways or elevated to form rapid transit lines to suit the traffiic demands in the outlying districts of the city, and providing means of transportation on section and half section line streets now closed to traffic.

Chicago's transportation problem is essentially a rush hour one, and the present rush hour transportation facilities of the surface lines are suffering from the effects of vehicular and other surface congestion and insufficient track capacity, resulting in average slow schedule speed and insufficient cars per hour on the lines where the traffic demands are the heaviest.

Additional streets upon which to build additional tracks are not available in the territory affected.

Elevated tracks constructed in the streets are objectionable and private rights of way are prohibitive in the central business district by reason of high real estate values; therefore, the only alternative is to build subways beneath the streets. By subway operation the schedule speed of surface cars will be increased and by running the cars in trains of two or more in the subway the track capacity in cars per hour will be greatly increased.

This will result in extending the 30-minute zone for surface cars farther out from the central business district and very much increase the capacity in cars per hour, and with a unified surface and elevated system the following general service improvements can be realized:

Extend the 30-minute zone as far out from the central business district as possible.

Operate the elevated trains express through this zone.

Beyond this zone utilize the surface lines as feeders to the elevated rapid transit lines.

This will approach an ideal system and the public will be given the most comprehensive and effective service possible.

—*Geo. Weston.*

One often hears his neighbor upbraid the old-time farmer for his "bullheadedness" in holding to his own narrow ideas of farminb. They ask, why does he not profit by the advice and experience of our Federal Government, which annually spends millions of dollars experimenting for his benefit. Hundreds of publications of immense value to him are issued each year.

But why attribute all this neglect to the farmer? Are we not as neglectful regarding our interests? Let us, for instance, deal with one phase of this subject which is of particular interest to us as technical students and graduates, viz., the technical publications of our Government.

There are three divisions of our Federal government which have been of particular benefit to the members of the Staff: The U. S. Geological Survey and The Bureau of Mines of the Department of the Interior, and the Bureau of Standards of the Department of Commerce and Labor. There are, of course, other divisions whichc may deal more directly with the work any individual is interested in. The various departments of our Federal Government have issued papers of untold number and value which may be obtained for the asking. For accuracy of detail and thoroughness of matter, they are unexcelled by any text book or government report in any country.

The State Government as well as the Federal Government offers its experience to those who wish to make use of it.

Write for a list of publications and you may be surprised to find out what your government is doing for you.

"To think clearly, to speak plainly and to say the thing that ought to be said." —*Railroad Review.*

"A wise policy is of more avail than a large plant; good management, than perfect equipment."

—*H. L. Ganitt in Iron Age.*

Those who labor with their minds rule; those who labor with their bodies are ruled. —*Chinese Proverb.*

Art and knowledge bring bread and honor.—*Danish Proverb.*

By the work we know the workman. —*La Fontaine.*

A skilfull mechanic is a good pilgrim. . —*Shakspeare.*

"You can lead a man to office but you can't make him think." —*Railroad Review.*

"A man like a watch is to be valued for his goings." —*Chinese Proverb.*

An engineering foundation has been established. The basis is a gift of a considerable sum by a noted engineer for advancing the arts and sciences connected with engineering for the benefit of mankind. Inaugural ceremonies were held in the Engineering Societies Building, New York, January 27, 1915.—*Iron Age.*

ARMOUR INSTITUTE OF TECHNOLOGY BRANCH OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

There have been two regular meetings of the Society since the last issue of THE ARMOUR ENGINEER, one on March 14, and the other on April 12.

The election of officers for next year took place at the first meeting an dthe following men were elected:—

Honorary Chairman.........G. F. Gebhardt
President ....J. M. Byanskas
Vice-President ....'...B. S. Carr
Secretary ....E. S. Eklund
reasurer ....L. Luckow

A paper was also read by G. F. Wetzel, '16, on "Paints Used in Engineering Work." The paper contained a description of the constituents of the paints used on structural work and similar engineering work. Formerly, it was taken for granted that any kind of paint would do, but now large buyers test the paint submitted before purchasing. On government work the paint has to conform to the standard formulas worked out in the testing department.

At the meeting of April 12, Mr. F. G. Gasche, Chief Mechanical Engineer for the Illinois Steel Company, gave an illustrated talk on "The Evolution of the Modern Steam Engine and Power Plant Transmission as Developed in the Steel Industry." Mr. Gasche told of the rapid development of the steam engine for blower purposes and showed how rapidly the D-slide valve and the Zeurner diagram were going out of use. The method of making I-beams, channels, and steel rails was clearly demonstrated by the pictures shown.

The annua lbanquet of the Armour Institute of Technology Branch of the Mechanical Engineers was held on March 27, at the Railway Equipment Club. Talks were given by Prof. Perry, Prof. Paul, and L. W. A. Bunge. There were about forty members present, a goodly portion of whom were "Profs." and instructors. All reported an enjoyable evening.

—*E. S. Echlin.*

ARMOUR INSTITUTE OF TECHNOLOGY BRANCH OF THE AMERICAN SOCIETY OF ELECTRICAL ENGINEERS

The annual banquet o fthe Armour Institute of Technology Branch of the American Society of Electrical Engineers was held on Tuesday evening, April 27th, at the Great Northern Hotel. The election of officers for the ensuing collegiate year was the principal business matter attended to. Several speakers were present to talk on various interesting subjects, and the Seniors discussed their theses. A large attendance and a good time was enjoyed by all.

—*C. F. Wright.*

ARMOUR CIVIL ENGINEERING SOCIETY.

On Tuesday evenng, February 23, the society was addressed by Mr. Kelleher of the Universal Portland Cement Company on the subject "Modern Concrete Road Construction." His talk was illustrated with slides depicting different styles of roads now in use and concrete roads in their various stages of construction. The information given out was of especal concern to engineering students and most valuable to the prospective invaders of the field of Highway Engineering. Mr. Kelleher also pointed out to the students how an engineer should deal effectively with the men in the field under him. This also is a subject of wide importance which can best be brought to the students by an experienced man such as Mr. Kelleher. He was extended a hearty vote of thanks by the society.

On the evening of March 28, Mr. C. S. Holcomb, '10, now an engineer with the Chicago Traction Company, gave, with the help of lantern slides, a detailed description of the method of track laying for our City Surface Railways. He explained the methods of dealing with the various complications which arise at the intersection of car lines, and the solution of problems concerning the selection of materials for the rail beds. He also made the listeners well acquainted with the sizes and quality of rails used and the method of laying and repairing them in present day construction. After the talk, many questions were asked by the

students and professors concerning the subject dealt upon and gladly answered by Mr. Holcomb. Prof. Wells made a few concluding remarks reminding the students that such was the kind of talk expected from them some years hence when they will be asked to address the Armour Civil Engineering Society. The meeting was well attended.

Two weeks later, the members of the society were the guests of the National Fireproof Construction Company which gave a moving picture and stereopticon lecture on the construction of a modern fireproof sky-scraper in Chicago. The students were made acquainted with the varous building materials now put out by the company and extensively used in the construction of houses, apartment buildings, factories and other buildings.

On Friday evening, April 16, the society had a very large representation at the "Student's Night" meeting of the Western Society of Engineers. The advice given by the speakers of the evening seemed particularly applicable to Civil Engineers and it is assured will be well heeded. The following prominent engineers, members of the Western Society of Engineers, addressed the students and members: J. G. Wray, Chief Engineer, Chicago Telephone Company; W. H. Finley, Chief Engineer, Chicago & Northwestern Railroad; O. P. Chamberlain, Vice-President, Dolese and Shepard Company; E. H. Lee, Vice-President Chicago and Western Indiana Railroad; Ernest McCullough, Consulting Engineer; John W. Alvord, Consulting Engineer; C. F. Loweth, Chief Engineer, Chicago, Milwaukee and St. Paul Railroad; C. A. Morse, Chief Engineer, Rock Island Lines; Isham Randolph, Consulting Engineer; W. L. Abbot, Chief Engineer, Commonwealth Edison Company, and B. F. Affleck, President, Universal Portland Cement Company. The talks were brief and decidedly to the point. The Armour Glee and Mandolin Clubs entertained with a few selections. Cider, sandwiches, doughtnuts, and stogies were partaken of, by way of refreshments. It was an evening very well spent.

A large banquet will end up the year of the Armour Civil Engineering Society. The date has not yet been set but it will very probably be held at the Great Northern Hotel. All members and alumni are urged to attend.

CHEMICAL ENGINEERING SOCIETY

At the last meeting of the Armour Chemical Engineering Socity, Mr. H. B. Pulsifer, instructor in Metallurgy, gave a very interesting talk on the financial conditions of the metallurgical industries in this country. The various economic phases of the industry, as affected by present conditions, were clearly explained.

There will be one more meeting of the society this year. The new officers for next year will be elected, and it is hoped that they will carry on the good work started this year, and make the society a source of benefit and enjoyment to all.

The semi-annual banquet will be held the latter part of May, the actual date and place not having been decided upon at this writing. A very interesting program is planned, and it is hoped that all members will be present.

—*C. C. Congdon.*

FIRE PROTECTION ENGINEERING SOCIETY

The second year of the Fire Protection Engineering Society has undoubtedly been a great success. The membership has increased from fourteen, the membership when first organized, to a total of forty this year. This large increase is due to the increasing interest shown in Fire Protection work.

A great deal of the success of the Fire Protection Engineering Society must be credited to the interest shown by Prof. Fin nigan, whose attendance and advice at the meetings was always appreciated.

Talks by outside men were arranged for the first Thursday of each month, an dthe students from all departments were invited to attend. The meetings were held in the Engineering Rooms in Chapin Hall. The Society has been very fortunate in securing prominent men connected with the Underwriters Laboratories to give talks on the various phases of their work.

The next meeting, scheduled for April 30th, at 5:00 P. M., will be the annual business meeting, the election of officers for the ensuing year being the chief business of the meeting.

—*W. H. Rietz.*

THE ATELIER.

Before the next issue of THE ARMOUR ENGINEER the present Senior Class in Architecture will be no more, and the cold, cruel world will be enriched by twenty promising architects. Several of the fellows have already obtained good positions in offices, even though the forthcoming season promises to be a very poor one in the building line.

The Seniors are now busy on their theses. The object sought by Prof. Campbell this year has been to have the members of the class pick smaller subjects for their theses and to make something really good, rather than to select a large subject and to hand it in half studied, as was done in former years.

The Traveling Scholarship Competition problem, "A Palace for a Cardinal" has been completed, but has not yet been judged. The drawings, as a whole, are far better than last year's problem, and although a problem along ecclesiastical lines is something new for the school, and therefore hard to develop, the work done was very satisfactory.

Several of last year's graduating class, and also Prof. Campbell of the Architectural Department, have specimens of their work in the exhibit of the Chicago Architectural Club, which is now being held at the Art Institute. There are also exhibits of work done in the various architectural schools of the country, the University of Michigan, University of Illinois, University of Pennsylvania, Cornell, Carnegie Tech., Massachusetts Institute of Technology and Armour Institute of Technology.

Several members of the Junior Class were entered in the recent Brickbuilder Competition for "A Brick Church." The entire class made the preliminary sketches for the problem, but only those receiving mentions were allowed to enter in the competition. The remainder of the class also completed their design for a "Recreation Building and Pier," but it has not yet been judged.

The Sophomore Problem, "A Dairy Lunch Interior in Terra Cotta," is to be finished on Friday of this week. A new problem has been issued to the Freshmen, "A Niche in a Wall," with which they will finish the year's work in design.

The Seniors and Juniors were privileged to listen to a lecture on "The Composition and Uses of Paint in Structural Work," delivered by Mr. Guy Wetzel, who is the Chicago representative for the Vaughn Paint Company, of Cleveland, Ohio. It was very instructive and was appreciated by all who were able to attend.

The fourth Twelve-Hour Sketch Problem of the year was given to the Seniors and Juniors on last Friday. It was "A Soda Fountain in a Department Store."

S. A. Wolfrum and S. H. Minchin of the Senior class, went to Urbana last week, and took the state examination for architects. Several of the former graduates of the school were also in attendance.

A. B. Griffith made one of his semi-occasional business trips to Omaha last week. He is conducting extensive building operations in that city at present, which at times require his personal supervision.

—*E. W. Porter.*

THE ALUMNUS

Being That Part of *The Armour Engineer* Devoted to Personal Mention of the Graduates of the Armour Institute of Technology and to the Affairs of the Armour Alumni Association.

Edited by the Publication Committee of the Armour Alumni Association.

F. R. BABCOCK F. T. BANGS F. G. HEUCHLING

Communications should be addressed to F. G. Heuchling, 1310 Glenlake Ave., Chicago, Ill.

THE SPRING MEETING

The annual spring reunion and banquet of the Alumni Association will be held at Armour Institute of Technology on Saturday afternoon and evening, May 22, 1915.

It was our intention to make announcement in this issue of the entire plans for this event, but for some reason or other, T. A. Banning, genial Master of Ceremonies, and Stanley Dean, who is arranging the athletic program, are extremely reticent regarding the entertainment to be provided. We suspect that Banning is trying to make up for his absence at the last meeting and that he has some novel entertainment features he will use to vindicate himself and, merely as an incidental matter, make the occasion one of added interest and enjoyment.

The publication committee managed to extract the information that the program would commence at 3 P. M. with a baseball game, which would be followed by a tug-of-war. It was

not possible to ascertain the contestants in these events. Suffice to say, they will occur. A portion of the rope used in the tug-of-war will be taken to the testing laboratory and subjected to a breaking test. Prior to the test those present will have the opportunity of estimating the strength of the rope and a prize will be awarded to the person making the most accurate estimate.

Supper will be served in the gymnasium at 6:30 P. M. Tickets, $1.25 per plate. Banning would not say more than that there would be features at the banquet. What kind, we do not know. But we are inclined to think there will be some notables present, and that they will address those assembled. The novel features should make their appearance about this time. We do know the reunion will close with the annual election and installation of officers, and since that has ceased to be a move-the-secretary-cast-a-white-ball-for-the-candidate affair, with spirited slate opposition, some fun can be expected from this source.

We do not know what Banning has in the way of surprises and "novel" features, but he will make good. Even if he should not, you know from experience that there will be a jolly good time, your old professors and classmates waiting to greet you at this year's spring reunion at "old A. I. T." Don't forget the date, Saturday, May 22.

TO THE SENIORS

A few words to the Seniors will not be out of place at this time of year. It is natural for those who are soon to become alumni to be interested in an association composed of alumni. It has seemed to us that if the plans and purposes of the association were properly presented to the class some measure of the benefit to be derived from active membership in a flourishing alumni association would be explained, and you could be counted upon after graduation to give active support to the organization.

Up to the present time you have doubtless given but little thought to the subject of the relation of the alumnus to his Alma Mater. It is a matter, however, that will have a constantly increasing interest and its importance should be realized now. The time is opportune; for as commencement day approaches you will surely be in a mood to appreciate any appeal for continued loyalty to A. I. T.

The Armour Alumni Association was founded in 1900, and it speaks well for the enthusiasm of the early graduates that they effected an organization only three years after the first class was graduated. The principal object of the association at that time was to arrange for annual meetings. With a limited membership great progress was not possible, but persistent efforts were constantly made for a better organization, with the result that in 1910 a new constitution was adopted and a scholarship loan fund established. This fund has been conscientiously administered and has been the means of lending assistance to many needy undergraduates.

In an effort to continue the advances made by the organization an arrangement was made with the ARMOUR ENGINEER in 1913 to have an alumni department in this publication. In order that all members of the association, especially those who are unable to attend meetings, may receive some return from their membership the dues were made to include a subscription to this magazine. There was a demand for some sort of alumni publication, for it is a means of communication with members, keeps them in touch with one another, and is needed to further the progress of the organization. The Alumnus is not considered as an end but as a means, and through it the ideas of more efficient organization may be worked out and much done toward the preservation of the ties that should unite all A. I. T. men.

Unless you have given the matter more thought the field for Alumni influence in the work of the Institute may appear small. It appears so because the influences are somewhat intangible. But there are many ways in which your aid may be given. For instance, your superior conduct and success after graduation will be an indication to your associates in the business world of the quality of the institution of learning you were graduated from. Maintain the highest standards, not only for your own good but for the welfare of that institution, and if there is opportunity for concerted aid through the medium of the alumni or any other association your helping hand will accomplish more and your duty will be more fully done.

Aside from your duty to the Institute there is another call that should not be overlooked. This is your obligation to the schoolmates who contributed to your education. You will come to

know in a short time that your studies were but a small part of the education derived from four years' attendance at A. I. T. and you will soon discover that your success is dependent upon many other things than your ability to execute engineering work. Many of the qualities that you will find necessary have been acquired more by contact and association with your fellow students than by the work of the classroom. This being true you will be deeply indebted to your college mates for such success as you may attain.

You came to Armour Institute with high ideals, but you know that during your four years there they have been strengthened, broadened and made more a part of the very fiber of your being. This is not so much because the ideals at the Institute are unusually high, but because they are unusually well lived up to. You will always treasure in memory the recollection of those professors and students who stood ever for the right principle at whatever cost.

Of the many qualities essential to success with the average man, none, perhaps, are so important as loyalty and persistence. A proper appreciation of the men above you in any work undertaken and the disposition to second their efforts to the best of your ability, will go far towards securing recognition in any field. Add to this the quality of persistence; the willingness to stick when unforeseen difficulties arise; to meet discouragement with renewed effort; to fight in fair and foul weather; to stand the punishment without complaint that comes to all fighters, and success is sure to be yours.

These and many other qualities you owe in great measure to association with A. I. T. men. It should not be expedient that the relations that have been both pleasant and profitable should end with your graduation. Membership in the association and attendance at its meetings brings you in close personal contact with men who have had many years of experience in engineering work and business activities. You will find that membership in no other organization will give you as great an opportunity of learning from the experience of others.

Graduation marks the commencement of your life's serious work; let it also mark the continuance of your loyalty to A. I. T. friends. Become a member of the Alumni Association before

leaving the Institute. That your introduction to the association may be fitting an invitation is extended to the Senior class to attend the spring meeting as guests of the association. Your presence will not obligate you in any way, and you are assured a good time and a hearty greeting from the Alumni. The spring meeting will be held at the Institute, Saturday, May 22, afternoon and evening.

THE TWENTY-FIFTH ANNIVERSARY CELEBRATION

The committee in charge of the arrangements for this event is at present formulating a statement of its plans for the celebration. This statement will be formally presented at the spring meeting of the Alumni Association and will be open for discussion. Up to this time the plans have met with general approval. However, the committee will be glad to receive any ideas that will make for a "bigger and better" celebration, and we hope all alumni who can will lend their presence and aid at the spring meeting.

IN RETROSPECT

Following is a brief statement of the activities of the retiring officers and managers of the Alumni Association during the past year:

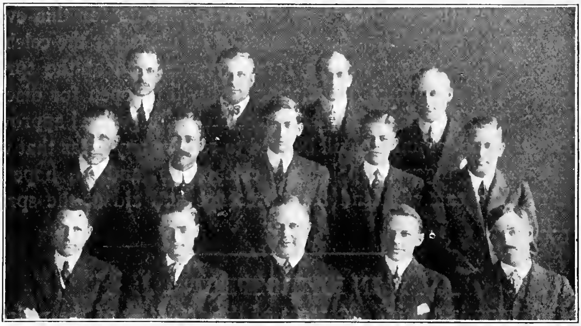
Meetings were held September 26, October 28, November 22, December 19 (mid-winter banquet), March 5, and March 22.

Work of the committees: Scholarship Loan Fund, E. F. Hiller, Chairman—Loans to the extent of $185.00 made in 1914-15. Publication, F. T. Bangs, Chairman—Arrangements made with the ARMOUR ENGINEER and Alumni Department edited. Auditing and Finance, H. W. Clausen, Chairman—Report to be made at end of the year. Anniversary Celebration, E. O. Griffenhagen, Chairman—Preliminary plans drawn up for celebration in 1918 of the 25th anniversary of the founding of Armour Institute. Booster, F. R. Babcock, Chairman—Notices of meeting, etc., sent to members.

Work of officers: Corresponding Secretary, Stanley Dean—Roster card notices sent out and revised list of all graduates completed. Master of Ceremonies, T. A. Banning, Jr.—Arrange-

ments made for mid-winter banquet and for the coming Spring reunion. Treasurer, Tracy W. Simpson—Handling of all dues and other money received and expended. All committee chairmen and other officers reported at the meetings and the work accomplished or to be taken up by them was discussed by the board.

An investigation was made of the omission of the name of Armour Institute from the list of higher institutions of learning in Illinois as compiled by the North Central Association of Colleges and Secondary Schools.



OFFICERS AND BOARD OF MANAGERS OF THE ARMOUR ALUMNI ASSOCIATION FOR 1914-15

Top row (left to right): Swift, Durr, Hiller, Lindberg. Center row: Bangs, Babcock, Heuchling, P. F. Griffenhagen, de Beers. Bottom row: Dean, Simpson, Clausen, E. O. Griffenhagen, Banning.

The retiring officers and managers extend their sincere thanks to the active alumni who have supported them so well in their efforts to further the progress of the Association.

ALUMNI NOTES

J. I. Menkin, '09, who has been working in Winnipeg, Man., has accepted a position as special agent, New York Life Insurance Co., 304 Stock Exchange, Chicago.

E. F. Hiller, '06, chairman of the Scholarship Loan Fund Committee, has changed his address to 624 E. Fifty-first St., Chicago. He urges members of recent graduating classes to avail themselves of the opportunity of securing life memberships in the Alumni Association.

A. T. Fors, '13, is employed in the engineering department of the Goodman Manufacturing Co., Chicago.

C. H. Jones, '09, is now general foreman of electrical construction, Chicago Elevated Railroads, Edison Building.

W. F. Sims, '97, formerly construction superintendent, Stone & Webster Engineering Corporation, Boston, Mass., is now associated with W. N. McMunn, contracting engineer, 112 W. Adams St., Chicago.

Tracy W. Simpson, '09, who has been manager of the Specialty Sales Department of the Federal Sign System, Chicago, for the past nine months, has been made Western District Manager and Vice-President of the Federal Sign System (Electric) of California, San Francisco. The latter company operates a factory and has a selling organization in five states on the Pacific Coast and the appointment, which became effective May 1, is a substantial tribute to Mr. Simpson's capabilities. On behalf of the Alumni Association, we wish to thank him for his efficient services as Treasurer of the organization during the past year, and hope that he will attain continued success in the West. He extends a cordial invitation to all Armour men attending the Fair to call on him in his new offices.

W. C. Brubaker, '06, was recently appointed chief engineer of the new Pullman Free Manual Training School, Pullman, Ill. He has been foreman of the templet department of the Pullman Car Co. for some years.

H. M. Sharp, '05, of Bryan, O., has recently been made deputy construction commissioner for the state of Ohio.

What the 1914 Men Are Doing

T. Agazim is employed as chemist by the By-Products Coke Corporation, South Chicago, Ill.

G. S. Barber is working for his father, E. W. Barber, architect, 210 Hammond Blk., Superior, Wis.

A. W. Barr is in Mobile, Ala., working at his profession as architect.

T. C. Bolton is employed by K. C. Gaynor, consulting engineer, Sioux City, Ia.

H. L. Case is employed in the engineering department of Marshall Field & Co., Chicago.

G. A. Cooley is working for the Rich Tool Co., 2503 S. Wood St., Chicago.

O. A. DeCelle is chemical engineer with the International Filter Co., 38 S. Dearborn St., Chicago.

W. C. Dumke is in the inspection department, Commonwealth-Edison Co., 72 W. Adams St., Chicago.

H. E. Erickson is working for Armour & Co., Chicago.

O. H. Goetz is working for the Stromberg Motor Devices Co., 68 E. Twenty-fifth St., Chicago.

W. H. Goetz is in the engineering department of the Crane Co., 836 S. Michigan Ave., Chicago.

H. D. Gumpper was employed by the American Steel Dredge Co., Ft. Wayne, Ind., until recently, when he accepted a position as efficiency engineer with the Baltimore & Ohio Railroad, at Baltimore, Md.

C. Halperin is employed as architectural draftsman in the office of C. W. Kallal, City Architect, Chicago.

R. M. Heim is assistant detail engineer, Electrical Engineers Equipment Co., 711 Meridian St., Chicago, Ill.

C. C. Heritage is chief chemist, Nehassa Edward Paper Co., Port Edwards, Wis.

J. A. Holmboe is assistant superintendent for the Bailey-Marsh Co., builders, Minneapolis, Minn. At the present time he is engaged in construction work for his company at Grinnell, Ia.

H. E. Jedamski is in the Bridge Department, City of Chicago, 2001 City Hall Square Bldg.

L. M. Jensen is employed by Fred Petersen, architect, Omaha, Neb. His address is 2811 Burdette St.

Nathan Koenigsberg is draftsman for Leon E. Stanhope, architect, 1821 Harris Trust Bldg., Chicago.

E. C. Lang is employed by the City of Chicago, Department of Gas and Electricity, 614 City Hall.

A. W. Morrow is practicing architecture, with offices at 1461 Monadnock Blk., Chicago.

H. Perlstein is junior sanitary chemist, Municipal Laboratory, City Hall, Chicago.

Joel Pomerene is employed as surveyor by the United States Engineering Department at Peoria, Ill.

H. D. Roller is instructor in drawing, Nicholas Senn High School, Chicago.

J. A. Shakman is assistant chemist with Walter H. Flood, '06, consulting chemist, 326 River St., Chicago.

C. G. Schmidt has opened an architect's office in his home city, Portland, Ore. His address is 455 E. Twentieth St., N.

Walter Steininger is in the estimating department, Joseph T. Ryerson & Son, Chicago, Ill.

J. W. Turner is working for the Chicago Engineering and Inspection Co., consulting engineers, 766 Peoples Gas Bldg., Chicago.

S. P. Walker is working for the Lytle Construction Co., Sioux City, Ia.

C. L. Wetzel is working in the service department of the Kansas City (Kansas) City Light Department. His address is 1134 Haskell Ave.

J. A. Whittington is employed in the research department of the Mineral Point Zinc Co., De Pue, Ill.

L. T. Wilson is chemist for the Southern Works, National Lead Co., 900 W. Eighteenth St., Chicago.

C. E. H. Wolfley is working for Tallmadge & Watson, architects, 1004 Security Bldg., Chicago.

William Yongman is chemist with the Dearborn Chemical Co., 2005 McCormick Bldg., Chicago, Ill.

Joseph Zavertink is working for the Barrett Manufacturing Co., 2900 S. Sacramento Ave., Chicago.

ALPHABETICAL INDEX OF ADVERTISERS.